Science & Mechanics

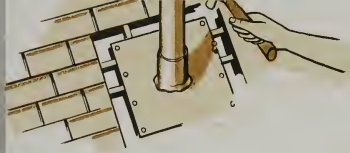
Complete HANDYMAN ENCYCLOPEDIA

do-it-yourself

17

SPEAKERS
SWIMMING

Complete Handyman do-it-yourself Encyclopedia



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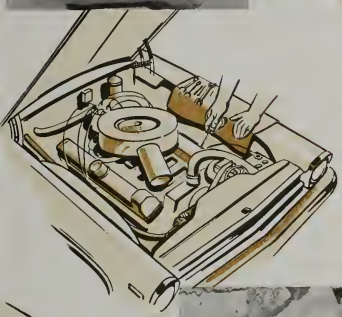

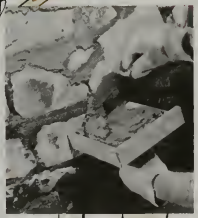

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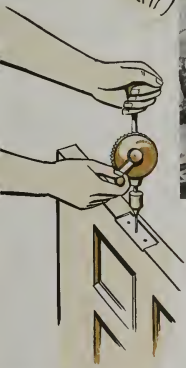

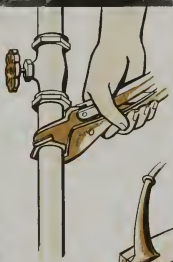

Complete Handyman yourself Encyclopedia

A COMPILATION OF NEW AND PREVIOUSLY PUBLISHED SPECIAL INTEREST PROJECTS AND MANUALS FOR THE REPAIR AND CARE OF HOMES, AUTO, APPLIANCES, HOBBY EQUIPMENT.

by the editors of

Science & Mechanics

17

SPEAKERS
SWIMMING

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VOLUME 17

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Build a Nine-unit Stereo Speaker

This combination of four tweeters, four mid-range speakers and one woofer can provide a big sound

ANY good speaker should sound big, even if it's small. Big in the sense that it is expansive, which too often means expensive. Another way a speaker can sound big, to our conditioned ears, is with rich bass. A speaker that combines full bass with spacious highs will sound big at both ends of the audio range.

This nine-speaker unit offers big sound at a low price because you build your own wide-sound speaker system. Even with a high compliance 15-inch woofer for the bass and multi-directional high compliance mid-range speakers and dome tweeters for the highs, your speaker cost is less than $100 per enclosure. And you can make two enclosures from only 1½ sheets of ¾-inch unfinished plywood. A few tools are all you need, particularly if you have your local lumberyard cut out the parts for you.

After getting the parts home, mark and cut out the speaker holes at the proper locations as shown in the drawing. The outside edges of the holes for the mid-range speakers and the tweeters should be beveled off with sandpaper, a file, or a saber saw set at 45°. If left intact, the sharp edge at the outside of the speaker panels can cause

speakers, bookshelf: see stereo
speakers, four-channel: see stereo
speed control: see mixer

diffraction and interference effects which will affect the mid-range and high-frequency response.

Speaker cutouts. Select a sample speaker of each size and center it at each speaker hole. Mark the location of pilot holes for speaker mounting screws. Drill $^3/_{32}$-inch pilot holes for the mid-range speakers and tweeters. For the woofers drill $^1/_4$-inch holes at each mark and install T-nuts from the front of the board to receive $^3/_{16}$-inch stove bolts. If you can't find $^3/_{16}$-inch T-nuts, you can substitute slightly longer $^3/_{16}$-inch flat head stove bolts installed from the front.

Next set up the parts on your workbench to form a partial enclosure. Mark a line where the edge of a panel butts against another panel. For example, you will mark lines on the bottom and sides to outline the edge of the front panel when the front is flush with the front edges of the other panels. You will also mark lines on the bottom to show the inner edges of the sides, and so on, until you have outlined the position of each panel. Next, measure and cut glue blocks to fit each corner location. The approximate length of the glue blocks is given in the Materials List, but you may find that minor differences in panel dimensions will require these lengths to be trimmed or increased slightly.

Now attach glue blocks to panels, using glue and screws. It is much easier to install all the glue blocks at once, with the panels flat on your workbench, than later after the panel is fastened to another panel. Drill shank holes of about $^{13}/_{64}$-inch through the blocks at 4-inch to 6-inch intervals. Nail the blocks lightly in position and drill pilot holes in the panel with a $^3/_{32}$-inch drill. Next apply glue to the block and the panel; then attach the block to the panel and screw it down. Note that the blocks should be indented $^3/_4$-inch from the front and back edges of the sides, $^3/_4$-inch from each edge of the bottom, and $^3/_4$-inch from the back edge of the partition. The other 3 blocks on the partition are flush with the edges because this panel sets inside the sides and front.

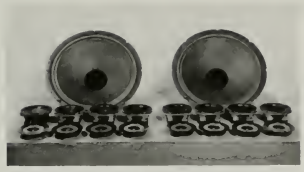
Drill shank holes in panels for assembly screws. These should be located at about 4-inch to 6-inch intervals on lines to match the center line of each opposing glue block. For example, there will be a line of screw holes around the perimeter of the front panel and back panels indented about $^3/_8$-inch from the edge. Also a line of holes at the bottom and the top of the sides. Don't forget a line of holes about $6^3/_8$-inch below the top edge of the front and sides to bind the front and sides to the glue blocks on the lower side of the partition.

Attach sides to bottom with glue and screws. Next glue and screw the front panel to the sides and bottom. Use glue and nails to join the sides to the front above the partitions where there are no glue blocks. Paint the front panel and sides with flat black paint. This completes the assembly of the basic box, minus the top and back panels.

Install the speakers. When the glue has set and the paint has dried, the speakers can be installed. Start with the tweeters. Smear a very thin layer of caulking compound on the speaker board to seal each tweeter to the board. Silicone rubber caulk is ideal for this job. Set the tweeter on the ring of caulking material, and screw it down.

Now install the mid-range speakers with screws and the woofer with bolts. Both mid-range units and the woofer have adequate gaskets, no caulking compound needed. The mid-range speakers should be mounted upside down so that their terminals are pointed up for easy wiring.

Install the crossover network with four non-magnetic screws, aluminum or brass, and with "spacers" between the crossover network board and the partition. Pieces of plastic tubing or rubber grommets about



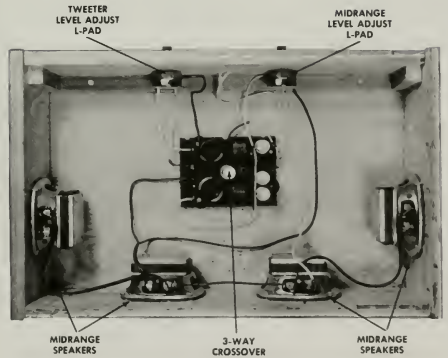
▲ *A total of eighteen speakers fill your room with a powerful sound. Woofer has a polyfoam suspension and low resonance.*

⅜-inch long will serve as spacers or stand offs. After the screws are installed, tap the network board lightly and check for rattles. If loose, the board will tend to "sing," but not very musically.

Drill two ¼-inch holes through the midrange back (H), for the speaker leads. Ream the holes on the outside of the back so that a two-terminal strip, screw type, will fit flush against the back. Split a 12-inch piece of lamp cord far enough to feed the two leads through the holes from the inside of the back, and solder them to the terminal strip. Install the strip with glue and small screws.

Install the controls. Drill ⅜-inch holes

▲ *The assembled speaker stands a full three feet tall, nearly two feet wide. Trim both top and bottom after stapling grille cloth.*

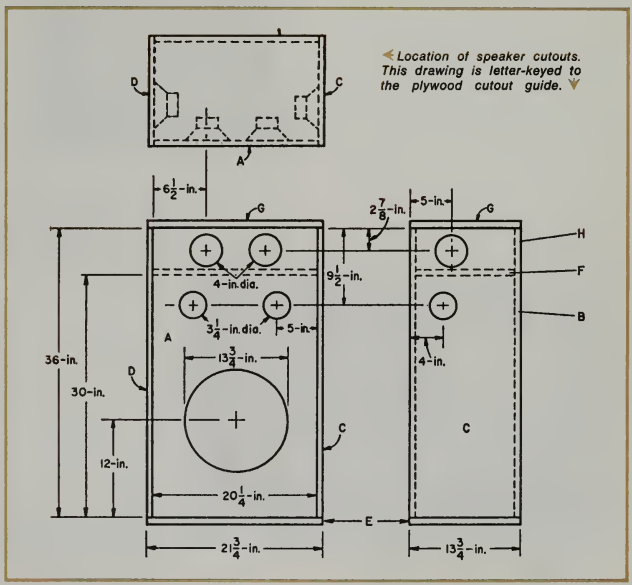


◀ *Remove top cover to see L-pads, crossover network, and the four midrange speakers. Parts substitutions are possible.*

for the control shafts; then enlarge the holes on the outside surface with a ¾-inch drill to recess the retaining nuts. Tighten the nuts on the shafts, then stick the control plates on the back with contact cement. Install the mid-range back panel with screws —no glue.

Wire the speakers using lamp cord for conductors. The logical first step in speaker wiring is to connect the paralleled pairs of mid-range and tweeters. Wire the left pair of each in parallel, and the right pair of each in parallel. Use care to see that the same conductor on a piece of lamp cord goes to the red dot on each speaker in the pair. After the pairs are wired, connect the pairs together by a single conductor from the red dot terminal on one pair to the unmarked terminal on another pair. This puts the two parallel pairs in series when the four speakers are wired by connecting the proper tap on the crossover network through the control to the red dot on one pair and the unmarked terminal on the other pair as shown in the drawing.

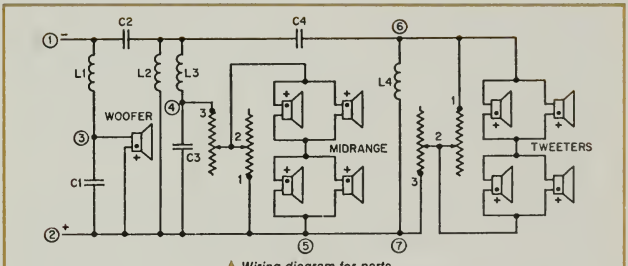
In order to keep the wiring straight, it's a good idea to split several pieces of brown lamp cord and equal lengths of white lamp cord. Use the individual leads to connect the speaker to the network and controls, a brown lead for negative and a white lead for positive, or vice versa. The leads to the



woofer and tweeters can be carried through the partition through two ¼-inch holes. After wiring, fill the space at each end of the holes with caulking compound.

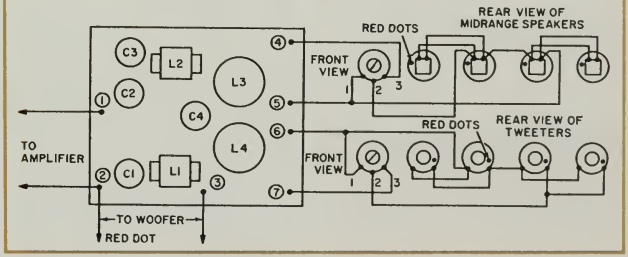
Before soldering the speaker wires, hook up the system to an amplifier or other source and test to see if the speakers and controls are working right. Keep the volume low when the back is off. You should hear bass from the woofer, mid-range from the squawkers, and highs from the tweeters. Now listen to each mid-range speaker in turn, without changing any controls on the amplifier or the speakers. Each of the four speakers should be producing sound at equal loudness. Perform the same test with the tweeters. Operate the controls to see if they reduce the volume of the mid-range, or tweeters, when rotated to the left. Double check your wiring and, if satisfied, solder all lugs. Connect a 1½-volt flashlight battery to the terminal strip. Reverse the battery if necessary until the woofer cone moves forward at contact. Put a drop of red paint on the terminal connected to the positive pole of the battery.

The woofer compartment should be lined with a minimum of about 2 inches of fiberglass batting on the walls and back panel. House insulation grade of fiberglass is low in price and works very well, but first it must be stripped from its paper

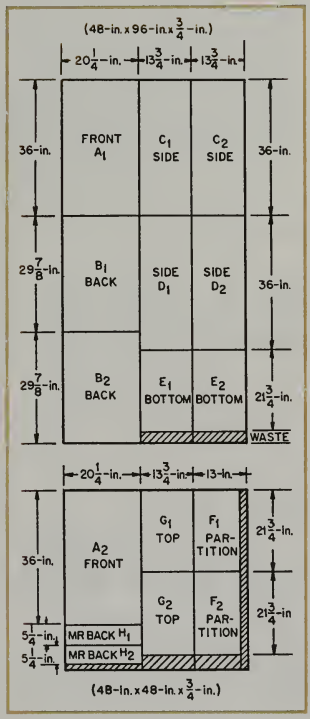


▲ *Wiring diagram for parts.*

▼ *A pictorial wiring of the speakers, L-pads, and crossover.*



backing. The fuzzy edge should be faced away from the walls, toward the cabinet interior. The chief purpose of the fiberglass is to kill reflections in the upper frequency of the woofer, but it will also help slightly to reduce any tendency toward booming. You can experiment with different amounts of fiberglass until the woofer sound is right.



▲ *Cutout guide provides you with pieces for two complete systems. Letters refer to those in drawing showing location of speaker cutouts.*

Screw down the back, then prepare the top. The top will be installed with screws through the sides, back, and front into blocks under the top. The blocks should be cut to short lengths, except for a long block at the back, so that they can be positioned at intervals between speaker positions. Glue and screw the blocks to the underside of the top. Before installing the top, loosely fill the mid-range compartment with fiberglass pads. Arrange the pads flat so that their edges face the speakers.

Finishing touches. It is somewhat easier to stain and finish the top and trim pieces before putting on the grille cloth. Sand lightly, stain, and finish to your own taste. Staple grille cloth to the back edge of one side and wrap it around tightly; then staple or tack at the back edge of the other side. Install the trim pieces with finishing nails. If glue is not used, you can easily remove the trim and grille cloth later for a change of cloth.

Now connect the speakers to your amplifier. Observe polarity by connecting the red dot terminal of each speaker system to the positive sides of your amplifier output terminals. Begin listening with the mid-range and tweeter controls fully clockwise. If the sound is too bright, adjust the tweeters back by degrees. If the bass is less prominent than you like, rotate both mid-range and tweeter controls counterclockwise until the sound is balanced. Unless your room is acoustically asymmetrical, such as heavy curtains near one speaker, you should try to keep the controls on both speakers at similar settings for good stereo performance.

If you are not used to a large woofer, you will note the difference right away. Amplifier controls may require different settings than for small speakers. But the important difference is that there is a firm-

MATERIALS LIST

Quantity	Size and Description	Purpose
1	3/4" 20 1/4"x36" plywood	front panel
1	3/4" 20 1/4"x29 7/8" plywood	back
2	3/4" 13 3/4"x36" plywood	sides
2	3/4" 13 3/4"x21 3/4" plywood	top and bottom
1	3/4" 13"x20 1/4" plywood	partition
1	3/4" 5 1/4"x20 1/4" plywood	mid-range back
4	3/4" 3/4"x28 1/4" pine	vertical side blocks
6	3/4" 3/4"x20 1/4" pine	top rear, bottom, partition front and back
4	3/4" 3/4"x10 3/4" pine	bottom and partition sides
2	1/4" 1 3/8"x13 3/4" trim	top
1	1/4" 1 3/8"x22 1/4" trim	top
2	3/4" 2x13 3/4" trim	base sides
1	3/4" 2x23 1/4" trim	base front
as needed	#8 1 1/4" flat head wood screws	
as needed	#8 3/4" pan head sheet metal screws	mid-range speaker mounting
as needed	#8 1/2" pan head sheet metal screws	tweeters
as needed	3/4 1 1/4" round head stove bolts with washers	woofer mounting
1	15" high compliance woofer (CTS-FR-15-20-8)	
4	5" high compliance speakers (XS-510)	
4	3" tweeters (CTS-2TA3)	
1	3-way crossover network, Norelco (4304-07X)	
2	8-ohm L-pads (Radio Shack 40-980 or equivalent)	

NOTE: Also need 3/4" T-nuts, flat black paint, terminal strip, lamp cord, glue, etc.

ness to the bass that is missing with most small systems.

With the proper balance you will begin to appreciate the advantage of the side facing speakers. A change of listening position produces much less change in stereo quality than with conventional speakers. Also, the better dispersion produces the illusion of a wider sound source, a big one.

A further advantage is that mid- and high-frequency power is divided between four speakers. Each of the small speakers is working far below its power limit, with reduced distortion in the frequency ranges where the ear is most sensitive to distortion. The result is a smoother sound. Two units add up to impressive stereo. D.W.

See also: ELECTRONICS; HIGH FIDELITY SYSTEMS: STEREO.

WHERE TO FIND IT

For further information about CTS speakers, write to McGee Radio, 1901 McGee Street, Kansas City, Mo. 64108. However, you can substitute similar size speakers and parts from other sources.

Two Spice Racks for Your Kitchen

Take your choice. Either of these two designs—one includes a clock—can be completed on a weekend

SPICE RACKS ARE OFTEN merely functional shelves built onto the insides of cabinet doors. If you have the available wall space, why not bring the spice rack out into the open where it is more accessible, and where it can add a distinctive decorative touch.

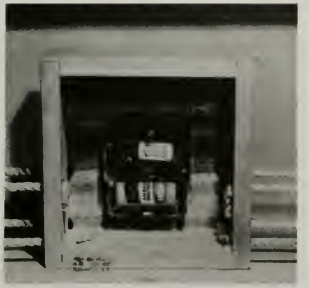
Either of these racks will do even more. Both provide drawers for storage of recipe cards and other small items; one also has a clock for timing cooking to perfection.

The rack components can be assembled using conventional joining methods. How-

▲ *Corner posts are glued in place after rope holes are aligned. Glue also anchors rope ends.*

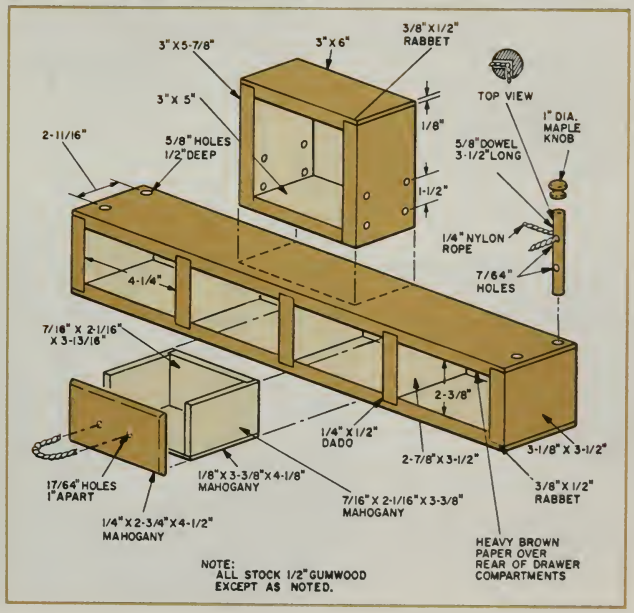
spiders: see pest control
splices: see knots

Two Spice Racks for Your Kitchen 2479



▲ *Clock facepiece overlaps edges of box—not vice versa. Box is constructed separately and glued in place.*

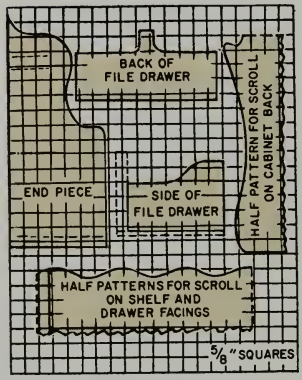
◀ *Rear of clock box with movement in place.*



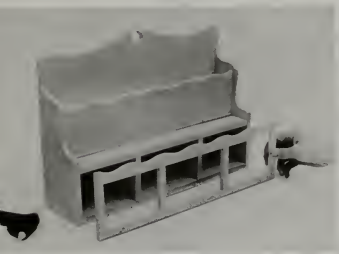
ever, to save time and labor, consider using an electric glue gun that utilizes stick glue. This type of adhesive sets in less than a minute, and there is no need to use clamps of any kind; simply apply the hot glue with the gun, then hold the sections together by hand until the bonding material sets. The glue guns are available in most hardware stores.

The Early American-style rack is made of pine finished with a warm stain that is in keeping with your colonial kitchen decor. Use a jig saw, saber saw, or even a hand coping saw to cut the curved front, end and back sections. The front is preferably cut from a single piece of wood, or it can be assembled from separate pieces glued together. Both front and back pieces lap over the ends, not vice versa.

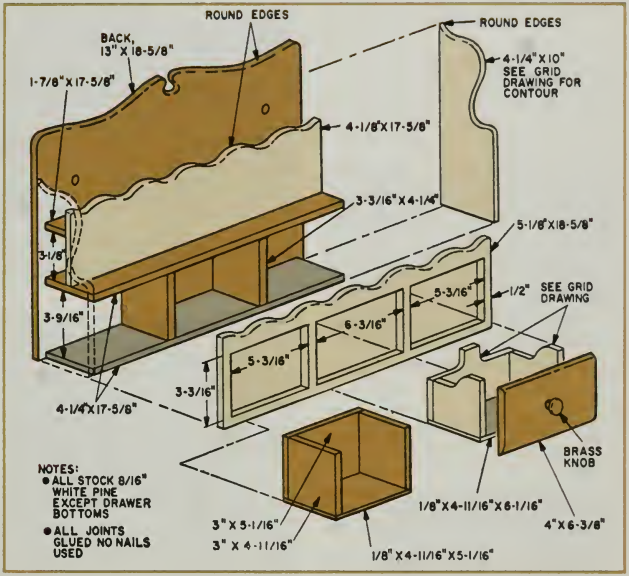
The rack will look better if you round the curved edges. A sharper does this best, but careful hand-working can also yield a creditable job. Note that the center drawer —used for filing recipe cards—differs from the other two; the sides are shaped so as to permit tilting for installation, and a tab at the rear acts as a drawer stop.


BACK OF FILE DRAWER
HALF PATTERN FOR SCROLL ON CABINET BACK
END PIECE
SIDE OF FILE DRAWER
HALF PATTERNS FOR SCROLL ON SHELF AND DRAWER FACINGS
5/8" SQUARES
CONTOUR PATTERNS

The nautical style rack, with the clock,



▲ *Round Early American rack's curved edges and bond parts. No clamping is needed if you employ fast-drying stick glue and gun.*



is even easier to build since it calls for no curved pieces and needs no face panel. It is more appropriate in a contemporary style kitchen. Use a combination of gum wood and dark mahogany—the latter for the drawer fronts and the clock face.

Note that the lipped drawer fronts simply butt against the compartment framework. Lengths of nylon rope, glued into holes, serve as handles.

The clock box is made separately, and then glued in place as shown. The dial for the clock is made by gluing short lengths of dowel into holes drilled into a ¼-inch thick piece of mahogany along a circle that will bring them close to the tips of the clock hands. Use the hands that come with the clock mechanism. Note that the clock face laps over the edges of the box.

The posts at the top of the cabinet are intended to simulate a ship's capstans. The nylon ropes attached to them are anchored in place with glue.

See also: ADHESIVES; PAPER DISPENSER, KITCHEN; WALL DECORATIONS.

WHERE TO FIND IT

The clock movement is available from The Armor Co., P. O. Box 290, Deer Park, N. Y. 11729. Write to them for information.

How to Splice Wire Like a Pro

Stranded cord, such as lamp cord, is best stripped with wire strippers. A knife, unless carefully used, will sever many of the thin strands and can be hazardous.

Follow a few simple rules and you can make safe, permanent connections in electrical wiring

STRIP, TWIST, SOLDER, TAPE. Making a safe and permanent electrical splice is as simple as that, provided that you observe these basic rules:

1. Strip insulation carefully to avoid breaking wire strands or knicking solid wires.
2. Twist the bared wires correctly for maximum strength.
3. Solder for added strength and reliable performance. Avoid excess solder by heating one side of the splice with the soldering iron while applying solder to the *opposite* side of the splice—not to the soldering iron.
4. Insulate with an approved electrical tape, not with makeshift materials.

Be sure to match the insulation *colors* when adding new lines to BX house wiring. Join black to black, white to white, red to red. Otherwise you may defeat the grounding of the fixtures—with shocking after effects. J.H.

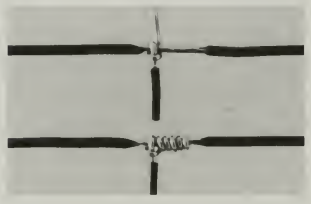
See also: CIRCUITS, ELECTRICAL; ELECTRICITY; WIRING, ELECTRICAL.

Use staggered splices on lamp cord for smoother and safer joining. Cut and strip wire as shown at top, twist together and solder smoothly, as shown, with one splice. Be sure to insulate with electrical tape.

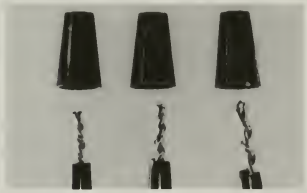
Pigtail splice can be insulated with electrical tape, if plastic wire nut is not available. Fold a double thickness of tape over the end, bind in place by spiral-wrapping with more tape.

When splicing white lamp cord, camouflage electrical tape with white tape.

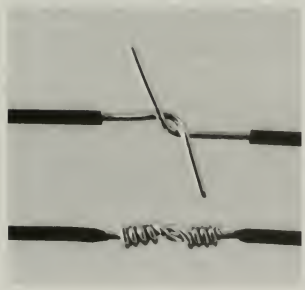
Tap splice can be made by simply twisting about three inches of bared wire around a 3/4-inch bared section on the main line. A better way is to wrap around once and loop around tap wire itself before continuing the splice (top). Solder and tape completed splice (below).



Heavy wire, such as used in BX cable, is best stripped with a sharp knife. Shave insulation off at an angle, as if sharpening a pencil, to avoid cutting the wire.



One right, two wrong. A pigtail splice must be twisted clockwise (left) to get best joining with a wire nut. If twisted counterclockwise (middle), screwing on of nut will loosen the wires. At right, only one wire has a twist, hence the other can pull out under tension even after the nut has been screwed tight.



Start an end-to-end splice (Western Union) as shown at top. Finished splice (below) is neat and strong, ready for soldering and taping. Insulation of top wires was removed with stripper, that of bottom wires was "pencil shaved."

How to Remove Spots from Rugs and Carpets

The sooner you act when something spills on the carpet, the greater the chances of removing the spot. Use this handy guide to match the cleaning method to the type of stain

SPOT REMOVAL CHART	
OILY AND CREAMY SUBSTANCES	Use dry-cleaning fluid or absorbent powder cleaner.
SUGAR AND STARCH	Wipe spot with cloth wrung out of clear water.
MILK	Sponge with detergent solution, then clear water.
BEVERAGES	Use clear water or detergent solution.
ACID SUBSTANCES (FRUIT JUICES, ETC.)	Blot up liquid as soon as possible with damp cloth; sponge several times with clear water. If spot remains, sponge lightly with solution of 1 tablespoon of ammonia or baking soda in quart of water.
BLOOD STAINS	Sponge with cold water. If spot remains, use small amount of detergent and water.
NAIL ENAMEL	Quickly blot up as much as possible, taking care not to spread the spot. Lacquer thinner or nail polish remover may remove spot. (Do not use on rayon or rayon-and-wool blends—it will dissolve the fibers.) Apply liquid to small area, then blot up excess.
PET SPOTS	Sponge urine spot thoroughly with clear water and blot quickly. Go over spot with detergent solution, then wipe off with cloth dampened with clear water, blotting up excess. If spot has dried, saturate with solution of 1/2 cup white vinegar to a cup of warm water and let stand for a few minutes. Blot and repeat treatment until discoloration disappears. Then dry carpet as quickly as possible. For regurgitated food, scrape up solid materials. Sponge with clear water and blot up liquid. Follow with neutralizing given under Acid Substances.
INK	Washable—use damp, absorbent cloth. Ballpoint—use dry-cleaning fluid. Permanent—consult a professional.
RUST	Try clear water. If unsuccessful, consult a professional.
CIGARETTE BURNS	If burn chars only surface of rug, use sharp shears to snip away blackened ends of tufts. Sponge with detergent solution, then clear water.
WAX	If wax has dried, use stiff bristle brush to remove solid matter. On spots caused by paste or liquid polishing wax or no-rubbing furniture wax, use dry-cleaning fluid. If stain remains, rub with warm soapy water or foam-type rug cleaner. Spots from self-polishing floor wax and cream-type waxes should be cleaned with warm water and detergent. If necessary, follow with foam-type cleaner.
UNKNOWN	If fresh; absorb all liquid possible with clean, slightly damp cloth. Scrape off solid material carefully with spatula or spoon and pick up with cloth. Sponge with cloth wrung out of clear water. If spot remains after drying, use solution of detergent and water, followed by sponging with cloth dampened with clear water. If possible, raise rug to let back dry.

spray adhesives: see adhesives
spray gun: see painting, auto
spring-flowering bulbs: see flowering bulbs
spring pole partitions: see partitions
sprinklers: see gardening

How to Remove Stains from Floors

Whether the floor is tile, wood, cork or stone, there's a method to remove stains. This guide tells you what that method is

THE METHOD RECOMMENDED FOR removal of a stain may be effective on the stain but may be injurious to the floor. For instance, most solvents dissolve asphalt tile, acids etch marble and terrazzo, and strong alkalis destroy linoleum and cork and damage the grouting in ceramic tile. The accompanying chart lists common stains, and numbered references are made to the list of removal methods for specific stains. A method specifically prescribed for one type of floor should not be tried on another type floor because it will damage the floor.

Try the methods in sequence as they are listed in the three columns of the chart progressing to the next proposed method only if the first one listed does not work. For example: In removing ink from an asphalt tile floor, try (1) synthetic liquid detergent and warm water first and if this will not work, then try (16) ink remover; if this won't work, try (4) oxalic acid in water.

Make a small test first to determine if a

Those "impossible" floor stains can be removed, when you know what to use.

particular method will work. Begin at the outer edges and work toward the middle to prevent the spread of the stain.

Apply a poultice about one-half inch thick. Poultices, in drying, absorb moisture that has penetrated the stain and draws the stain out with the moisture.

See also: FLOORS.

STAIN REMOVAL CHART

Stain	Resilient Tile	Wood or Cork	Nonresilient Floors
Alcoholic Beverages	1, 10, 4	1, 10, 4	1, 10, 5
Blood	11, 12	11, 12	11, 32
Candy	1 and 3	1 and 3	33
Chocolate	6	6	6
Coffee	7, 8, 9	7, 34, 9	7, 34, 9
Dyes	13, 14, 9	13, 14, 9	13, 5, 9
Fruit	2, 4	2, 4	2 and 15
Grease or Oil	1	29	30
Ink	1, 16, 4, 17	1, 16, 4, 17	1, 21
Iodine	18, 19, 20	18, 19, 20	18, 19, 20
Lipstick	1 and 3, 4	1 and 3, 4	1 and 3, 5
Paint	1 and 3	4	31
Rust	22	22	22
Soft Drinks	4	4	5
Soot	23, 1 and 3	23, 1 and 3	23, 1 and 3
Tar	24, 25, 26	24, 25, 26	24, 25, 26
Tobacco	27, 5, 9	25, 5, 9	27, 5, 9, 28
Urine	9, 5	9, 5	9, 5
Varsol	35	35	35

STAIN REMOVAL METHOD

Method	Stain
1. Synthetic liquid detergent and warm water	Alcoholic beverages, candy, grease or oil, ink, lipstick, paint, soot
2. Synthetic powdered detergent and warm water	Fruit
3. Grade 00 steel wool	
*4. Tablespoon of oxalic acid in pint of water	Alcoholic beverages, fruit, ink, lipstick, soft drinks, paint
*5. Absorbent cloth soaked in hydrogen peroxide laid directly over stain; an ammonia-saturated cloth on top of this	Alcoholic beverages, dyes, lipstick, soft drinks, tobacco, urine
*6. Use ammoniated alcohol: 9 parts denatured alcohol and one part stronger ammonia (26%)	Chocolate

STAIN REMOVAL METHOD (Cont.)	
Method	**Stain**
7. Saturate an absorbent cloth with solution of one part glycerin and three parts water and lay over spot	Coffee
*8. Apply a poultice made of one part chlorinated lime and three parts washing soda and calcium carbonate. Allow to stand until dry. *Do not use on linoleum.* Use poultice of hydrogen peroxide and whiting	Coffee
9. Poultice of abrasive powder and hot water	Coffee, dyes, tobacco, urine
*10. Follow with denatured alcohol if necessary	Alcoholic beverages
11. Try cold clear water first, then add a few drops of ammonia	Blood
*12. For old stains try 2 ounces salt and 2 drams formic acid in pint of water. Soak stain for an hour or so, then rinse and blot up with absorbent cloth	Blood
*13. Try a chlorine bleaching agent	Dyes
*14. Apply solution of one tablespoon permanganate of potash to pint of water. When dry apply solution of one tablespoon oxalic acid to pint of water.	Dyes
15. If rough spot results rub with powdered pumice stone under a block of wood	Fruit
16. Ink remover	Ink
17. If a brown stain remains, treat as a rust stain	Ink
*18. Apply ammonia	Iodine
*19. If stain is old or deep, apply ammonia-saturated cloth	Iodine
*20. Poultice of denatured alcohol and calcium carbonate	Iodine
*21. Poultice of two tablespoons sodium perborate in pint of water mixed into a paste of calcium carbonate	Ink
22. Poultice of calcium carbonate mixed with one part sodium citrate crystals to six parts water added to an equal portion of glycerine. Allow to stand 2 or 3 days	Rust
23. Cover with salt or rub in calcium carbonate and rub off. Wash with synthetic detergent and water	Soot
24. Poultice of synthetic powdered detergent and whiting	Road tar
25. Stoddard solvent on any floor *except* asphalt and rubber	Roofing tar
26. Freeze to brittleness with dry ice. Scrape off	Roofing tar
27. Lemon juice in water	Tobacco
28. Equal parts alcohol and glycerine	Tobacco
29. Pour kerosene on spot. Soak for 5 minutes. Wipe dry with clean cloth. Wash with synthetic liquid detergent and water	Paint
30. Pour Stoddard solvent on spot. Rub with clean, soft cloth	Paint
31. One pound synthetic powdered detergent in one gallon water. Scrub and rinse with clear water	Paint
32. Wet spot with lukewarm water and sprinkle with powdered malt. Let stand an hour and rinse	Blood
33. Use synthetic scrubbing pad and synthetic detergent	Candy
*34. Poultice of hydrogen peroxide and calcium carbonate	Coffee
35. Poultice of synthetic powdered detergent	Varsol

PRECAUTIONS: Wear rubber gloves when working with these materials. Always pour ecids into water. Wear face shield to protect eyes and face against splashing fluids. Wear chemical resistant gloves when working with materials marked with an asterisk(*).

All about Wood Staining

Why hide a beautiful wood with paint? Instead, stain it to increase the attractiveness of the surface, then protect it with a clear finish

MUCH OF THE BEAUTY of a wood lies in its grain and color—the grain is the wood's natural markings and cannot be changed. However, the color of wood can be altered or changed to create a more beautiful effect by the process of staining—and it can be done by even the beginning craftsman. Staining is necessary for most raw woods since they are usually rather pale and mildly figured, adding a tone of color helps to bring out their inherent beauty. Staining can also help to even the color of a wood which varies widely—simply stain the lighter parts to match the darker. Stains are available in a wide variety to match wood tones such as blond, maple, walnut, honey birch, brown mahogany, etc.—as well as in such colors as blue and green for creating exciting new effects.

Oil stains. These are the conventional type stains and are the easiest to handle. They may be applied with a brush, roller, or spray and are available in forms suitable for use on cement, exterior shingles and shakes, and a variety of other surfaces. There is a wide range of colors in these type stains available at paint and hardware stores. Oil stains do not cause a wood grain to raise as do stains that contain water. They give wood a rich, deep tone but sometimes reduce the clarity of the grain pattern. They are not as permanent in color as certain other types and are not generally used for staining new furniture.

Pigmented wiping stains. These are also called stain sealers and are available in a wide range of color tones, which can be intermixed to offer an even wider variety. The pigments are in suspension in a penetrating-resin vehicle. This type stain must be stirred constantly to assure even distribution of the pigments. These wiping stains are effective in achieving uniform appearance or in staining a piece of furniture made from different woods. Wood must be smoothly sanded to secure a uniform appearance. Soft, porous woods darken heavily since they soak up more of the color, while harder woods absorb less stain. Pigmented wiping stains generally perform best on white pine and other softwoods. They also furnish a good method by which to create a "distressed" effect to a finish since they help accentuate cracks, dents and scratches.

Follow the manufacturer's label directions when applying pigmented wiping stains. Be sure to stir frequently and to give a uniform coverage to the entire area. If

stain removal: see spot removal
stains: see painting, house
stairways: see home improvement

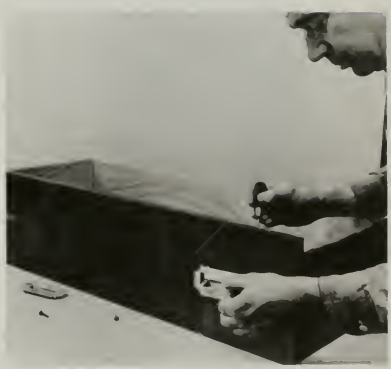
you are going to use more than one can of stain, mix the cans together in a large container to insure uniformity of color.

Pigmented wiping stains in a penetrating resin help seal the wood, to a degree. Places such as paneling which do not get much abuse can be finished with a topcoat of wax or a coat of shellac or varnish. On problem areas which usually require three coats of varnish, you will need to apply only two.

Water stains. Use of these stains requires a bit of skill and experience and is not often recommended for beginners. Water stains are sold in packets of powdered aniline dye to be mixed with boiling water, and the amount of water added to the stock solution determines the richness or deepness of the color. It is often difficult to predict what the finished color will look like, since these stains are strong and woods vary in their ability to absorb them. It is wise to experiment carefully with these dyes on pieces of the wood you are working with. In experimenting to determine the desired color, always coat the sample of stained wood with a coat of clear varnish or lacquer —this shows what it will look like when finished. Be sure to follow the manufacturer's label directions when diluting and applying a water stain. Since water stains will usually cause the grain of a wood to "raise," it is best to take preventative measures first. Merely grain-raise the surface first by flooding the area with warm water. This will cause whiskers to stand up, soft-grain areas to swell, and the surface of a well-stained wood will again become slightly rough. Let the flooded surface dry, then sand again and apply the stain. Water stains are applied by flooding the surface—which practically guarantees uniform distribution. After a few minutes, wipe away any surplus to insure that puddles won't cause overstaining. Water stains generally take overnight to dry, but this may be shortened under good drying conditions (gentle heat will help evaporate the water).

▲ *Careful preparation is important for a good job of staining. Fill all holes and cracks.*

▼ *Remove hardware and fixtures before working on furniture, or on doors or woodwork.*



Varnish stains. There are no suspended pigments in this type of stain, but dyes which are dissolved in the varnish solvents. They are seldom useful for more than obtaining a quick colored finish for noncritical work. The labels on these type stains usually correspond to wood names. Varnish stains are applied like varnish—with a brush. They are seldom applied to fine woods since they tend to cover up the grain pattern and the color is on the surface rather than *in* the wood. A more pleasing effect is created by using a pigmented wiping stain, then a coat of varnish. However, when the surface you are finishing is an inconspicuous one (such as the backs of chests, the bottoms of chairs and tables, or inside cabinets), using a varnish stain can be quite a time saver.

Application. Surface preparation is the most important step in the staining process, since a stain merely highlights and accentuates the surface to which it is applied. First remove all handles, hinges, and other hardware attached to the wooden surface. Masking these areas may take less time, but you may be sacrificing professional-looking results. If stain happens to get onto any of these metal parts, you will not only have a messy looking job, but may be clogging up some of the moving parts as well.

If the surface has been previously varnished or painted, you should purchase a

▲ *Unless the work already has a smooth surface, sanding is necessary.*

➤ *A vacuum cleaner can be used to remove dust from sanding. Removal of dust is essential for professional-looking finish. After the work is vacuumed go over it with a tack rag or a rag moistened with turpentine to remove all dust.*

▲ *Oil-based stains comprise a vehicle and pigment. Tinting colors can be used to adjust colors, if necessary.*

paint remover from your paint or hardware dealer and follow the label directions carefully to remove all traces of old paint until you reach the bare wood. Next, sand the surface thoroughly, following the grain, until smooth. Use the same fineness grade of sandpaper for the entire area to assure a more uniform penetration of the stain. Final sanding should be done with paper at least as fine as 6-0. Smooth down any rough spots—unless, of course, you want them to remain and contribute to a "distressed" effect. Remember that staining will accentuate any rough spots, including even the minor scratches of cross-grain sanding. Sanding should remove any grease, dirt and wax spots. However, you can make sure the surface is clean by wiping the entire area with denatured alcohol or lacquer thinner.

It is always best to test a stain first on a scrap piece of the type wood you are finishing—or on a portion of the furniture that will not show. If the object you are staining is composed of more than one type of wood, remember to test the stain on each of these woods. To test your color, apply the same number of coats you are planning to use and then apply the number of finishing coats (varnish, shellac, etc.) you will be using—even the "colorless" coatings will impart some color change to your final finish. If there is an uneven or blotchy distribution of stain on the test area, it may be wise to apply a "wash coat" of a clear penetrating sealer before staining. This will result in a lighter but more uniform color. Ask your paint dealer for a sealer made to be put on raw wood *before* staining. Follow label directions carefully and allow plenty of drying time before starting the staining process.

Various stains require different methods of application—so always carefully read the manufacturer's label directions and follow them to the letter. Stain products should be stirred thoroughly before using—and they should be stirred frequently during use to assure an even distribution of the color ingredients.

Stains are generally applied with either a soft, lint-free cloth or a brush. Your label

directions will specify the best method for the particular product. Apply the stain sparingly at first, taking care to follow the grain. Do not try to cover too much of the object at once—instead, work on one panel or section at a time.

Do not allow stain to remain on one section of the wood for too long a time while you try to cover the entire surface. The longer you allow a stain to stand before wiping, the more it penetrates into the wood and the darker the shade of the finish will be. If you want a lighter color, be ready to wipe it off quickly to pick up the excess stain before it is absorbed into the wood. In addition to the label directions, you must exercise your own judgment according to the depth of tone that suits you best. Keep track of the staining time when you are practicing on your test stain. Avoid overpenetration into the end-grain, brush and wipe almost simultaneously. Wipe hard.

Occasionally a piece of wood will stain lighter in one place than in another. In such cases there are two ways to obtain a more uniform finish:

1. Allow the stain to remain longer on the less absorbent wood, which you will recognize by its not taking the stain as quickly. And, where the stain soaks in rapidly, wipe it off quickly.
2. Apply a bit of diluted stain to the light areas and blend them into the darker surrounding wood. After this has dried, stain the entire surface. This method of obtaining a more uniformly stained surface is easiest with water stain. Pigmented wiping stains tend to seal the wood and prevent the second stain coat from penetrating.

If you find that more stain is soaking in than you had wanted—don't get upset. The degree of stain coloration can be lightened slightly with an extra hard wiping with clean rags or with a bit of fine steel wool. The surface can be lightened considerably by wiping it with a rag saturated in a solvent such as mineral spirits or turpentine—or

➤ *Applying stain with a brush. Different kinds of stains require different brush strokes. To be sure, check the directions on the container.*

One or more coats of clear finish—either varnish or a plastic-type finish—can be used to protect a stained surface. Do not use a high-gloss finish on fine woods. Application methods vary, but generally, varnish is applied first with a stroke across the grain, then with the grain. Do a small area at a time. Proceed to the next area quickly before the edges have a chance to dry. On new work, thin the first coat, according to directions on container; apply additional coats without dilution. Sand each coat very lightly with fine sandpaper before applying an additional coat over it.

whatever solvent the manufacturer recommends.

Wipe the stained surface carefully with a clean cloth when the desired color is reached. Some types of stains should be wiped with a rotary motion, while others require following the grain. Consult your label directions for the best wiping process for your particular product. Allow plenty of drying time before applying the clear varnish or shellac that may be recommended by the manufacturer. Some stains do not require a top coating, but you may buff them to impart an additional sheen.

Special staining techniques include pickling and antiquing.

A pickled finish is one in which an open grain wood is stained one color and filled with a contrasting color. For example, a natural-color paste filler can be applied to a wood surface that has been stained a dark color. Or, a wood surface can be stained with a light color, then filled with a dark wood filler.

An antique finish is one in which a stain or glaze is applied over a base coat. The base coat can be either painted or a stain. When the base coat is dry, apply a dark glaze or stain over it.

Apply the antiquing coat heavily, allow it to set for a few minutes, then wipe it or pounce it lightly with cheesecloth, a dry brush, burlap, crumpled newspaper or even plastic wrap. To create highlights, wipe away the stain or glaze in the center of flat areas and from high spots of moldings or carvings or outside corners. Leave a heavier application in the grooves, low spots and inside corners.

See also: ANTIQUING; FINISHING, WOOD; FLOORS; FURNITURE, USED; PAINTING.

How to Use a Staple Gun

This handy device offers a sure, quick way to attach almost anything to anything else, as long as the pieces aren't too hard or too thick. Some of the uses are shown here, but the complete list is limited only by your imagination

THE AUTOMATIC STAPLE GUN can be one of your most versatile hand tools for low-cost, care-and-repair projects around the house, in the garden, workshop, and for crafts and hobbies.

Insulating with a staple gun is simple because you can hold the insulation with one hand while you staple with the other. You don't need "three" hands, a helper, or a mouthful of nails. If you can place the stapler against the wall and squeeze, you can insulate. When installing insulation, start from the top and work down. Use $^{7}/_{16}$-inch staples.

Old furniture can be recovered in a jiffy with a staple gun. Almost all upholstered furniture is built around a wood frame. The rest is webbing, springs, stuffing and covering. Strip away the old covering, even the webbing; then recover or reweb simply by stapling new materials to the frame.

In stretching material to fit, shoot the staple at about a 45° angle to your pull. In other words, if you're pulling material straight down, hold your gun diagonally to the line of pull. Use $^{5}/_{16}$-inch or $^{3}/_{8}$-inch leg staples.

Your staple gun can also be used to tack material on valances.

Windows and doors can be rescreened in minutes. Place your door or window frame on a table or flat working surface. Raise it up about six inches. Place two clamps across the short side, toward the center, and tighten clamps slightly until it begins to "bow."

Now staple wire screening to the frame, stapling the short ends first. Then remove clamps and staple along the sides. Your screen door or window screen will be as taut and neat as a factory job. Use $^{5}/_{16}$- or $^{3}/_{8}$-inch leg staples.

Set 2 x 4-inch framing around the patio. Then tack wire screening around with your

starter, auto: see engine
static, boat radio: see electronics
staved columns: see hoppers
steam iron: see irons
stepladder: see ladders

staple gun. It's that easy to make yourself an outside screened-in porch or room. Make a temporary windproof winter play area by stapling clear plastic over screening. Use $^5/_{16}$-inch or $^3/_8$-inch leg staples.

It is easy to install ceiling tiles if you have a heavy-duty staple gun. Forget the nails or brads. Simply place tile in position with one hand and shoot staples with the other.

With your staple gun and any weather-stripping that would otherwise take a nail or tack, you can do a top-notch and low-cost job of weather-stripping the entire house. But don't overlook the asbestos or other heat-insulating shielding around the piping system.

If you find a worn or damaged asbestos covering, for instance, just gun-staple or patch over it using $^5/_{16}$-inch or $^3/_8$-inch leg staples.

You can staple felting to the floor wherever you intend to lay tiles, linoleum or rugs. The beauty of this time-saving trick is

▲ *When installing insulation, start from the top and work down.*

◀ *Reweb simply by stapling new material to the frame of the chair.*

that it works two ways: Quick installing, quick removing. After the felt is off, there is no messy adhesive to scrape off. Use $\frac{5}{16}$-inch leg staples.

Next time you want to label your flowers and vegetables, staple labels to wooden stakes and install. Use $\frac{5}{16}$-inch leg staples.

Protection for tree trunks and shrubs during the winter months can be accomplished with strips of burlap and wood posts. Simply wrap the burlap around the tree trunk (or around the posts in the case of shrubs) and staple.

If you're putting up new siding or roofing shingles, the quickest way to tar paper between the sheathing and siding, and to lay 15-pound roofing felt, is to use a staple gun. When installing tar paper, staple the outside edges at about every eight inches for a tighter weatherproof fit. Away from the edges, staple every twelve inches. Use a heavy-duty gun and ½-inch leg staples.

See also: CEILING TILE; WEATHER-STRIPPING.

Windows and doors can be rescreened in a few minutes.

Material can be neatly stapled to the wooden frame for new valances.

Tacking down weather-stripping on windows is easy to do.

A burlap protection cover for shrubs and tree trunks can be easily attached in this manner.

How to Choose Stereo Equipment for Your Home

Listen before you buy, and once you have chosen the equipment you want, try out speaker locations to hear how they sound before making a final installation

SINCE YOU'LL BE LISTENING to several sets before you buy a new stereo, take a familiar record in good condition with you when shopping for a set. You'll be able to decide more easily how each set measures up when you are listening to its performance on a record you have heard before so you are sure how it should sound.

Based on your preference, your set may include any or all of the following components: a stereo radio receiver, a record player, and a tape player. It will include a tuner, two amplifiers, and at least two speakers. Better systems include two each of the well-known "woofer" and "tweeter." High frequencies may also be produced by the use of a "horn." Horns are those efficient bell-shaped speakers which provide amplification by their shape.

Speakers may be either directional or omni-directional. Directional speakers project sound in one direction. Omni-directional speakers radiate sound in every direction. This 360-degree sound projection provides more reflected sound, as in a concert hall. It also guarantees that the listener will hear sounds from both speakers no matter where he stands in the room. High frequency sounds are highly directional and may be carried away from some parts of the listening room if they are projected in only one direction from directional speakers.

Air suspension speaker systems offer low distortion and accurate reproduction of low frequencies with small component speakers. The air suspension speakers are mounted in an enclosed, air-tight case. The compression of the air behind the speaker acts as a spring. This air spring allows a very even response to the signal from the amplifier and very accurate sound reproduction.

Solid-state stereo sets—those using transistors—are fully as versatile as those using vacuum tubes. With an improving solid-state technology, it is easy to get large amounts of sound power from solid-state sets, perhaps even more power than you will need in your home listening room. Solid-state sets generally provide more versatility for the money, smaller packaging, longer life, greater reliability, and are less expensive to operate than vacuum tube sets.

You'll want to be able to control tone and balance as well as volume on your instrument because, in the final analysis, it must be adjusted to produce the sounds you want to hear. Be sure to select a tuner with balance control. This control allows you to vary the volume of either speaker independent of the overall volume control. When you have achieved the balance of volume

stereoscope: see photomicrography
stereo speakers: see speakers
sticking doors: see doors
stone foyer: see foyer
stones, sharpening: see sharpening

between the speakers that you want, you can increase or lower the volume of both speakers together by using the volume control.

If you select a set which requires the volume of each speaker to be increased or lowered independently, you will have to balance speaker volume each time you want to turn the sound level up or down. Generally, two tone controls are provided on stereo sets—treble and bass. The treble adjusts the output of the higher frequencies, and the bass adjusts the output of the lower frequencies. Better sets provide a third control, timbre, which is a mute setting to make the sound more mellow.

Once you have purchased the set, you're going to have to decide how and where it should be placed in your listening room. Where possible, speakers should be placed at ear level. The distance between them should be 6 to 12 feet, depending on the size of the room. Usually, the player and the tuner will be placed between the speakers; however, this is not necessary. If you use no more than 50 feet of lead wire between each amplifier and speaker, a standard 18-gauge wire will be sufficient. Longer lead lengths need not affect the performance, but heavier wire must be used.

Be sure that the "left" speaker is placed so that it will be on the left side of the listener when he is in his favorite listening position, and the "right" speaker will then be on his right side. If your set is to be placed in a square room, place the speakers on a wall without a door, an equal distance from the side walls. Arrange the furniture so the listener will be sitting at the center of the opposite wall.

In a rectangular room, the speakers should be placed on one of the longer walls, the favored position for the listener being at the center of the opposite wall. In an L-shaped room, you will get good results if the speakers are placed along a long straight wall centered on the interior corner of the room. The favored listening position will be at that interior corner.

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➤ *Be sure to select a tuner with balance control. This control allows you to vary the volume of either speaker independent of the overall volume control. When you have achieved the balance of volume between the speakers that you want, you can increase or lower the volume of both speakers together by using the volume control.*

posite a soft wall covering such as drapes, tapestries, or a shelf of books. It's a good idea to experiment with speaker placement before finally deciding on a permanent location. The final judgment should be based on what sounds best to you.

If the speakers are fully enclosed, they can be mounted permanently with the back firmly against the wall. Some space must be left between the speaker and the wall if they are open back types.

Even if the speakers are placed perfectly, you will not get maximum pleasure from your set unless you adjust it properly. It is best to start with a monaural record. Set the tone control in its center position and then adjust the volume to approximately the level at which you will be normally listening. Using the monaural record, adjust the balance between the speakers until they appear to have equal volume.

After the volume and balance are adjusted, switch to a stereo record and adjust both treble and bass controls until you have reached a pleasing average. Don't be afraid to use the tone controls. All hearing is different, all broadcasts received on your stereo radio are different, and all recordings are different. Settings that seem "just right" for one record may seem slightly out of balance for the next because of such widely varying factors as the quality of the recording, the place where it was recorded, the instrumentation of the performing group, or even the style in which the music is played.

Even if you have properly placed the speakers and adjusted the controls, there are still things which you can do to the room itself to improve the quality of sound.

In theory, the ideal listening room would be completely "dead" so that it added none of its own characteristics to the sound produced by your set. In practice, however, a dead room would not only be too expensive to consider, it would not be very satisfactory because we are accustomed to hearing music in a room that contributes a little of its own personality to the sounds produced in it.

A practical listening room is a compromise between those factors which would tend to make music sound hard or brittle and those factors which would make it seem soft and mushy. It should be a fairly

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large room and would ideally be rectangular in shape. Dimensions of 25 feet by 20 feet with 8-foot ceiling would be perfect.

The large size is helpful for good reproduction of low frequencies. The rectangular configuration helps smooth the distribution of room resonances, thereby muting the room's sound personality.

Walls, floors, and ceiling of the room should be stiffer than is obtained in usual residential construction. This can be accomplished in several ways. The addition of a few extra layers of plaster to walls or ceiling will greatly increase their stiffness. In new construction, narrower than normal spacing of joists and studs or the use of stiffening plywood under the lath can help make walls less flexible.

Inside the room, the general rule is to arrange decorations and furniture so that soft surfaces (those which absorb sound easi'y) are opposite hard surfaces. The ideal room would be a mixture of soft and hard surfaces and soft and hard furniture. For example, tables with hard surfaces should be mixed with overstuffed chairs or sofas. Soft furniture should be placed near a hard surface wall, and hard furniture should be placed near a soft surface wall. The wall which is directly opposite the speakers should be of a soft surface, such as well draped windows, wall hangings, or shelves of books.

If you will have heavy rugs on the floor, the ceiling should be of a relatively hard surface such as plaster. If you are planning tile floors, some sort of soft ceiling tiles should be used. Even with the soft ceiling and hard floors, however, it is a good idea to scatter a few small rugs around the room.

Painted brick, ceramic tile, concrete, glass, wood flooring, polished solid wood, linoleum and similar materials are hard surfaces. Carpeting, draperies, soft tile, upholstered chairs and sofas are soft surfaces.

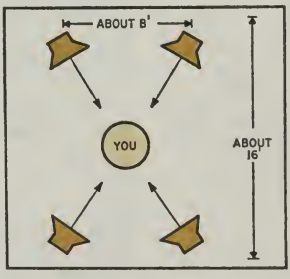
Remember, for the best effect, make sure your speakers are placed opposite a wall with a soft surface and make sure that each hard surface is faced by a soft surface. Balance is the goal, with you, the listener, being the final judge of how well it has been achieved.

See also: ELECTRONICS; HIGH FIDELITY SYSTEMS; SPEAKERS.

How to Place Speakers for Four-channel Sound

There are a variety of layouts you can try to achieve the sound you want to hear

TO OBTAIN THE TRUE BENEFITS of four-channel sound in your home takes a lot of common sense when it comes to locating the speakers. First, you must acknowledge that in general you are not prepared to redecorate the entire listening room just to squeeze in two more speakers. Somewhere along the line you must compromise on the speaker placement. Second, and more important, know in advance what you are



A showroom arrangement of four-channel speakers.

going to get in the way of four-channel sound, or rather, know how you can obtain the most pleasing sound from a compromised speaker arrangement.

The exact speaker arrangement depends on the type of four-channel sound you expect to use most frequently, for there is no ideal arrangement that will accommodate all the four-channel systems.

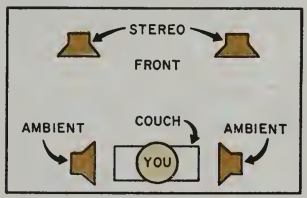
The most spectacular four-channel system is discrete surround, in which the program material is deliberately split up into four individual channels. Each channel can contain all the direct musical information for a particular instrument or section. You must, theoretically, place yourself at the sound center if you are able to hear the program as it was intended to be heard. Under ideal conditions this would require the speaker arrangement shown in the drawing of a showroom arrangement.

Slightly less spectacular is SQ four-channel, in which the program material is encoded in such a manner that when played back through a suitable decoder the listener theoretically hears essentially the same surround effect as if the program were in four discrete channels. However, in reality, SQ is nowhere near the equal of discrete four-channel. Optimum separation is about six dB between channels (at the present time). In a slightly reverberant room the whole effect is less spectacular than if you just placed two remote stereo speakers behind you. Obviously, outside the showroom, the recommended speaker arrangement of the drawing is not going to produce any "new dimension in sound." Other matrix (encoded) four-channel systems are in the same boat.

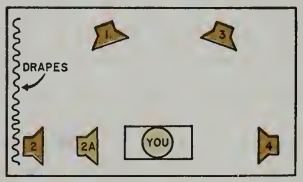
The third four-channel system is derived ambient, whereby a decoder extracts the ambient sound of the recording location that is "accidentally" encoded by the stereo microphones. Except that there can be little or no ambient from a mix-down recording, as used for pop music, where the band is recorded on tracks 1, 2, 3, etc.; and the vocalist is recorded on tracks 4 and 5, and the chorus on tracks 6, 7 and 8. The recording engineer puts it all together by mixing the eight (or maybe 16) tracks into two stereo tracks. An ambient rear output from a mix-down recording is as good as your imagination.

But putting aside any unusual problems —such as getting true ambient sound from mix-down, there are three basic four-channel reproduction systems, of which only the discrete system has inherent capacity for a spectacular surround-sound effect. The other two systems are going to require considerable juggling of speaker locations to obtain all the advantages of four-channel.

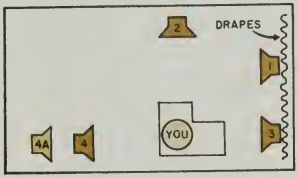
Let's start with SQ, because if the SQ



▲ *The usually suggested placement for four-channel ambient-sound speakers.*



➤ *An optimum starting point for placing SQ and discrete four-channel speakers.*



A compromise starting point for SQ and discrete four-channel speakers.

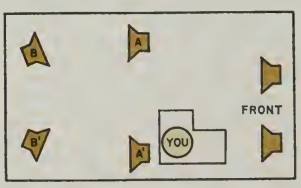
sounds good the discrete four-channel will also sound good. Under the best of circumstances—recording techniques, decoding, etc.—the sound from each of the four channels is a direct sound and should therefore reach your ears with essentially the same degree of room reverberation and time delay as from any other speaker. This is most easily accomplished by having each speaker an equal distance from your listening location, and by having an equal reflective surface in front of the speaker. Getting equal distance is no problem, most of the time.

The drawings show a variety of possibilities you might try, to overcome the problem of reverberations. Take the location of walls, drapes, furniture, etc., into account when trying out speaker locations. For example, if one speaker is in front of a wall and another is aimed at the same wall so that the sound bounces from the wall to your ear, each channel will sound as if it is coming from the wall, spoiling the surround-sound effect.

When the separation between speakers is maximum, you will always get the feeling of surround-sound. While SQ is supposedly also surround-sound, its sharply reduced separation can easily be turned into surround-mono in a reverberant room. Greater SQ separation can be obtained two ways: (1) move the speakers further away from the listening area in a "dead" room, or (2) in a reverberant room, rotate the speakers slightly, just enough so the reverb path does not come straight back at you from the walls opposite the speakers.

If you have one of the "logic" type SQ decoders, you will not have as much problem with reduced SQ separation because the decoder's logic circuits automatically reduce the gain of the three "weaker" channels, thereby creating the illusion of greater separation. (The effect is buried in what is conveniently excused as "psychoacoustics.") It might not be "real" four-channel surround-sound—if such actually exists, but it is a most pleasant effect.

If your listening environment is such that much of the surround-sound effect is being lost regardless of how the speakers are arranged and oriented, try to move them in as close as possible so as to provide the highest ratio of direct-to-reverberant sound



Some suggested starting points for diffuse ambient sound are illustrated in these drawings.

at the listening location. Since reverb tends to blend the higher frequency sounds from the four speakers (and it is the higher frequencies that are directive), reducing the blend by increasing the direct/reverb ratio often creates the illusion of greater separation, though it will also tend to make the sound slightly flatter, or lacking brilliance. (Again psychoacoustics!)

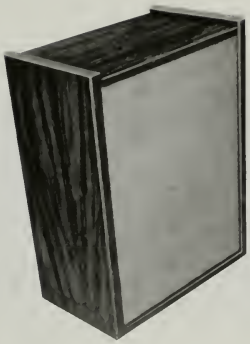
But just as you would want to reduce the reverberation blend for SQ, so would you want to boost the blend for derived ambient sound. Why? Because derived ambient is supposed to simulate the concert hall, or rock club. Now, when was the last time you attended a live anything and heard the sound from anywhere other than the front? The ambient sound of the hall—the reflections from the walls, floor, ceiling, furniture, and the absorption by the audience, create a vague spaciousness and overall tone quality we might define as "warm," "cold" or maybe "full bodied." Whatever the ambient sound does, it does not change the point or origination of the sound source, which is up front. (Yes, there are a few halls where a few seats appear to get their sound from the right and/or left side.)

Most speaker recommendations for ambient sound place the speakers as shown in the drawing, with the ambient "rear" speakers literally pouring the sound into the listener's ears. Just forget for a moment that nowhere does the ambient sound pour into the ear at a noticeable level, or from a specific direction. Consider, instead, that, depending on the record, the "rear ambient" might have considerable frontal energy and/or distortion in the form of "groove rattle" or intermod. Is this what you want?

Nothing in this world is going to duplicate a concert hall in your living room through speakers. At most, you will obtain a feeling of spaciousness which is a lot better than "standard stereo," and which might conceivably start to approach concert-hall realism. But you get this effect by diffusing the ambient sound either by a long path from the ambient speakers (which are at a very low level), or by blending the sound via rear-wall bounce. Some typical speaker arrangements for a diffuse ambient sound are shown in the drawing. The pairs of ambient speakers are indicated as A/A^1 and B/B^1. Again, the arrangements serve only to illustrate a starting point. Regardless of the final speaker arrangement, the balancing should be such that the ambient can barely be heard when the front speakers are off. While this is not going to "pour it down your ear" as it is done at a hi-fi showroom, after a few minutes of listening you will note a general depth to the sound field, with the sound orientation at the front where it belongs. In the long run, properly diffused and balanced rear ambient is the most enjoyable of all the four-channel formats.

Finally, most all sounds in life have a specific orientation or direction. Even the ear-damaging sounds of low-flying commercial jetliners have a recognized point of origin, even when we are feeling pain. The failure of most four-channel speaker arrangements and sound-field balancing is that the subconscious, expected sound orientation is disturbed. While the overall immediate (short-term) effect might be spectacular, it either wears quickly or the listener perceives less than standard stereo in terms of overall musical performance. However you arrange and level-balance your speakers for any four-channel system, certain sounds should retain a familiar orientation: vocalists and soloists should be up front—predominantly up front. Of course there will always be the A & R man or engineer that sticks one vocalist left front, another vocalist right front and a chorus spread out twenty feet across the rear. Just buy another record; it's simply another version of stereo ping-pong.

See also: ELECTRONICS; HIGH FIDELITY SYSTEMS; SPEAKERS.



Build a Pair of Bookshelf Speakers

This pair of speakers, each containing a woofer and tweeter in a two-way acoustic suspension system, will fill an average-sized room with sound

YOU CAN BUILD A GREAT speaker system with professional looks, feel and sound with these easy-to-build bookshelves. The secret is in the pre-finished material. Ready made bookshelves are available in hardware and building supply stores and make an ideal building material. You will also use unfinished shelving. For utility use, it is made of plain material ¾-inch thick and 11½ inches wide. Both are accurately cut in the lumber mill to even footage lengths.

The use of finished stock makes it possible to determine the appearance of an enclosure before it is built. A variety of wood grain finishes is available. The type that can withstand considerable handling and is impervious to scratching is vinyl-clad walnut wood grain—the same material used on side panels of modern station wagons. As with the plain, finished shelving is ¾-inch thick, at least 2 feet long and between 6 and 12 inches wide.

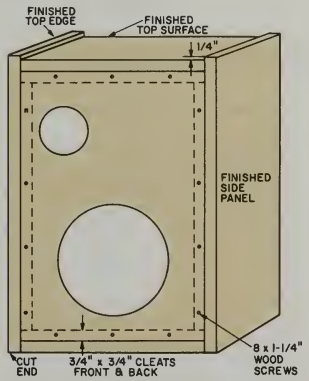
An important requirement for a speaker box is solid construction; it must be made as non-resonant as possible. Particle board is ideal for this purpose because, unlike most plywood, it has no cavities. It is a higher density material than plywood, easy to cut, and both sides are smooth and parallel. Also, the cost is low.

The construction of an acoustic suspension two-way system housed in a bookshelf-sized cabinet is shown here. The size is convenient for stereo in an average size listening room. To insure good performance from a small package, a high compliance woofer and a dome-type tweeter were selected. The woofer was designed to operate in an air volume of only half a cubic foot. In fact, the power handling capability (20 watts) is obtained when it is operated with just that volume.

The use of ready made shelves means that only five cross cuts are required to form the panels. Precautions, however, are necessary. When shelving is selected, it is important to observe that finished pieces will be solid throughout. Hollow lightweight shelves are now available; these cannot be

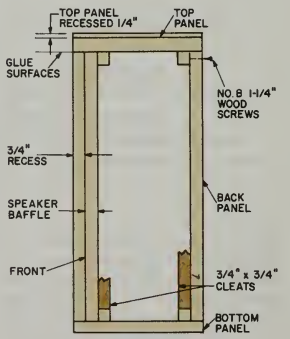
used. Check to see that the two finished shelves are the same width and that the ends are square on both the finished and unfinished pieces. Some shelves may be found where the ends are not quite square with the side edges.

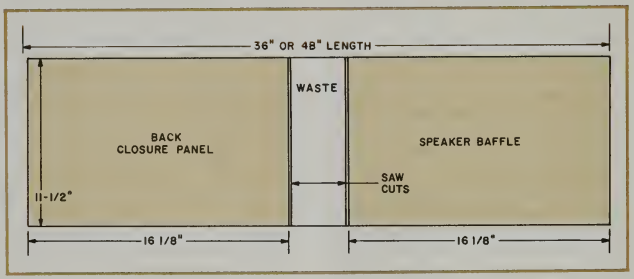
Note in the drawing that the side panels extend ¼-inch above the top. This provides a more modern cabinet design than the usual bookshelf speaker. Exposed cut edges are at the bottom where they cannot be seen.

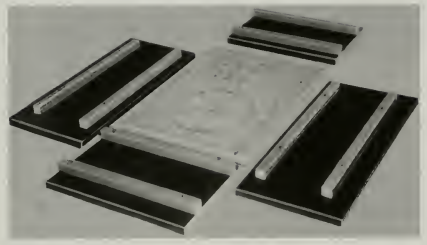


Square cleats are used at the front and back of the enclosure to hold the cabinet together. Note that the short cleats are the same length (11½ inches) as the top and bottom panels. The long cleats are fitted between the short ones.

To make maximum use of machine-cut square ends, cut the plain shelf as indicated in the drawing. This provides you with a speaker mounting board. Cut the 36-inch finished shelf into two parts of equal length to make the sides. These will be slightly less than 18 inches high due to the width of the saw. Cut the 24-inch finished shelf as



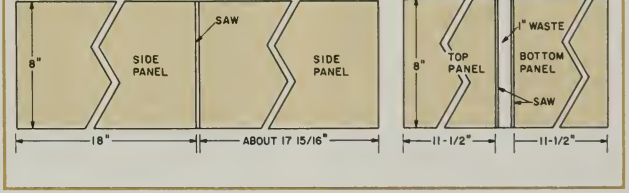


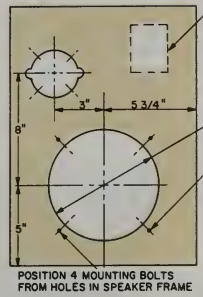


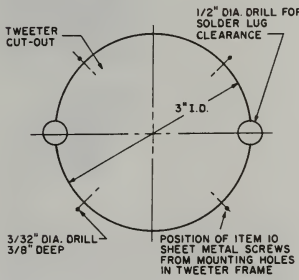
Fast and simple to build, two-way speaker system has woofer designed for bookshelf-size enclosures. Finished outside material gives professional, factory-made look. Shown here are the parts prior to assembly.

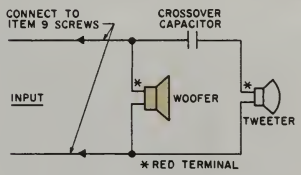
indicated in the drawing to make the top and bottom panels. Note the length; it is the same as the width of the speaker baffle and back. These cuts can be made by following a scribed pencil line with a saber saw. A fine-tooth saw should be employed to insure a clean cut.

When handling the finished panels, it is a good idea to place a piece of cardboard on the workbench to prevent abrasion of finished surfaces. Drill small holes at about an inch from the ends of the cleats and tack them in place, first the short ones and then the long ones. Hold one of the plain panels flush with a back edge as a spacer to locate the back cleats ¾-inch from the back edges. Place both plain panels together to space the front cleats 1½ inches from the front edges. When tacking, use 1¼-inch finishing nails but do not drive them down




CROSSOVER CAPACITOR MOUNTED ON INSIDE SURFACE
7-1/8" INSIDE DIA.
3"
5 3/4"
8"
5"
3/32" DIA. DRILL 3/8" DEEP FOR NO. 6 PAN HEAD SHEET METAL SCREWS
POSITION 4 MOUNTING BOLTS FROM HOLES IN SPEAKER FRAME

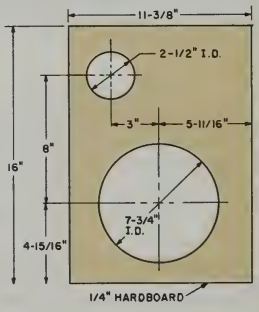

TWEETER CUT-OUT
1/2" DIA. DRILL FOR SOLDER LUG CLEARANCE
3" I.D.
3/32" DIA. DRILL 3/8" DEEP
POSITION OF ITEM 10 SHEET METAL SCREWS FROM MOUNTING HOLES IN TWEETER FRAME

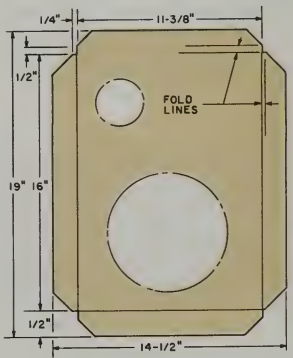


▲ *Substitute phone jack, terminal strip, fahnestock clips on your favorite binding post for brass machine screws it desired; "red terminal" connections are for proper speaker phasing.*

tightly. This tacking idea provides a trial assembly to insure that all parts fit properly.

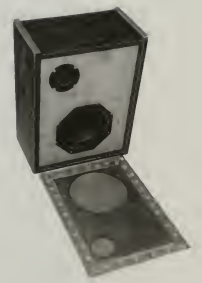
Make certain that the ends of the top and bottom panels make contact with the sides, and that the outside cleat faces line up all around. If necessary, move and cut the cleats. When all parts are fitted properly, strike pencil lines on the panel surfaces along both sides of each cleat, and mark the four panel junctions 1-1, 2-2, etc.





Simple, direct, point-to-point wiring, shown schematically, uses brass screws for convenient speaker-to-amplifier connection.

Thumbtacks secure grille cloth to 1/4-inch hardboard frame. Hefty enclosure has professional wood grain appearance.



(This will insure that all parts can be returned to the same position for final assembly.) Remove the cleats, coat all mating surfaces with plastic resin glue, then reinstall. Add another nail or two, at about 6½-inch centers, and drive the cleats down tightly. Nails are used in place of screws to simplify the work since their purpose is to hold the cleats until the glue has set. Plastic resin provides a joint stronger than the wood if the parts are held tightly during drying.

Scribe pencil lines along all four edges of the two plain panels ⅜-inch from each edge, and drill $\frac{3}{32}$-inch pilot holes at about 5-inch centers. Reassemble the enclosure and insert the plain panels, front and back. Mark the hole locations on the side faces of the cleats with the $\frac{3}{32}$-inch drill by turning it in each hole. The enclosure should be resting upon a flat surface in the upright position with the side panels held firmly together as the locations are marked. It is a good idea to drill the holes in the side of the cleats about ⅜-inch deep and remove the displaced wood. This will insure seating of the front and back panels to the cleats when they are screwed in place.

For wiring hookup, drill two ⅛-inch holes about 2 inches apart near the bottom edge of the back panel for #6 brass screws.

Scribe pencil lines on the other panel (speaker baffle) to indicate the openings shown in the drawings. Drill the two ½-inch holes before making the circular cuts for the tweeter cutout. These speaker openings can be made with a saber saw by slowly cutting along the scribed pencil line. Designate the marked face as the front. Speaker openings can also be made with a circle cutter or a router with a center guide attached. A cabinet shop in your town will cut the openings for a small fee.

The edge holes should then be enlarged to $\frac{3}{16}$-inch diameter for shank clearance of #8 wood screws; countersink for flat head screws if used. When all of the parts are ready for final assembly, coat the mating surfaces at the back with glue and screw the back panel in place. Insert the screws for wiring hookup and place the box on its back. Fit fiberglass damping material on the back, one side, and the top over the cleats. Thumbtacks or spots of glue are sufficient to hold the fiberglass in place.

The baffle can also be glued and screwed down, but both speakers should be fitted into the openings and the capacitor installed prior to the permanent installation of the baffle. Pan head #6 sheet metal screws ½-inch long are ideal for mounting the speakers. Use the holes in the speaker

MATERIALS LIST

Quantity	Size and Description	Purpose
1	3/4" 11 1/2"x36" particle board	shelf
1	3/4" 8"x36" finished particle board	shelf
1	3/4" 8"x24" finished particle board	shelf
1	3/4" 3/4"x10' fir	cleats
1	1/4" 11 3/8"x16" Masonite	grille cloth mounting
1	14 1/2"x19" grille cloth	
as needed	#8 1 1/4" steel wood screws	
as needed	3d 1 1/4" steel finishing nails	
2	6/32 2" brass machine screws	
as needed	#6 1/2" sheet metal screws	

NOTE: Also need speakers, crossover capacitor, non-polarized 4-ufd electrolytic hookup wire, plastic resin glue, fiberglass damping material and thumbtacks.

frames as a template for centermarking each screw location. Drill 3/32-inch holes to avoid the possibility of puncturing the woofer's cone by the slip of a screw driver. A "fail-safe" way to mount a woofer is to drill four 7/32-inch holes and insert 8-32 tee nuts on the back side for machine screws.

An 8-inch woofer, such as the type shown here, can be capable of better transient response than larger woofers, if it is equipped with a strong magnet to influence the voice coil. The 8-inch Philips (Norelco) AD8065/W8 is recommended due to its very low free-air resonance, rated at 28 Hz. Low free-air resonance is a necessity to hold down composite resonance which results when a woofer is backed into a small volume of air inside a box. In this enclosure the composite resonance value was found to be 58 Hz. If a new woofer is installed, the composite resonance can be expected to drop about ten percent after a year of use.

The 1-inch tweeter, Philips AD0160/T8, is a fine high frequency unit (dome type) available to home constructors. The dispersion characteristics are excellent and its range extends to 20,000 Hz. As with all high-frequency reproducers, it must be protected or isolated from low frequencies by a series crossover capacitor. The wiring hookup is shown in the drawing.

For grille cloth mounting, a 1/4-inch hardboard frame is recommended. Layout lines to the dimensions indicated in the drawing and cut the frame and cloth. If the grille material has a tendency to fray, spread a bead of rubber cement along the edges. Use the embossed pattern side (back side of the hardboard) for the front. Spread rubber cement around the two speaker openings to hold grille material tight to the hardboard. Use small thumbtacks on the back of the frame and more rubber cement along the edges. Hardboard is tough—thumbtacks must be hammer driven. The frame dimensions provide 1/16-inch clearance all around inside the opening. This dimension provides a snug fit with cane type cloth. Add masking tape to an edge if necessary for others. H.F.J.

See also: ELECTRONICS; SPEAKERS.

WHERE TO FIND IT

For further information about the woofer and tweeter used here, write to McGee Radio Co., 1901-07 McGee Street, Kansas City, Mo. 64108.

Put Your Stereo Speakers in End Tables

Easy to apply decorative molding gives these simple, inexpensive end tables an expensive look, and the speakers they contain radiate sound 360 degrees

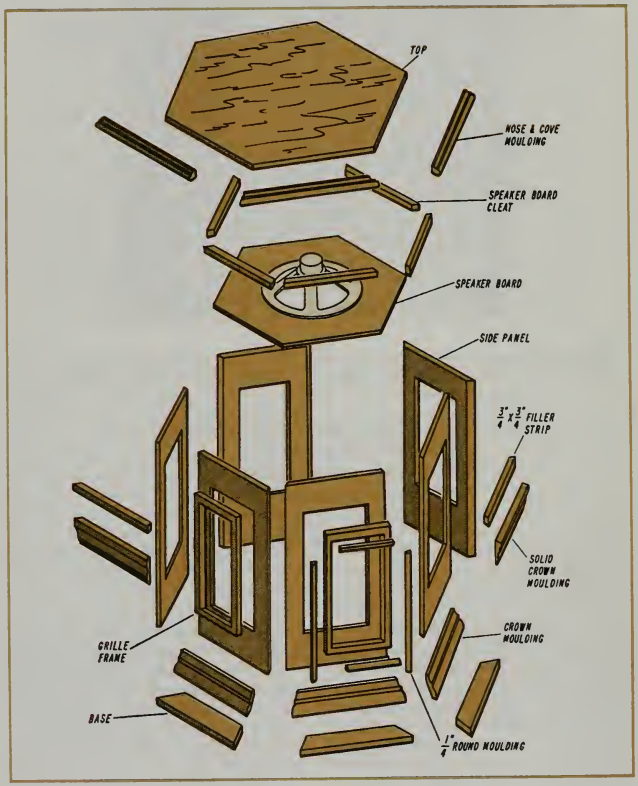
BEAUTIFUL MUSIC doesn't have to come from a drab box anymore, not when you can combine an exciting new concept space-saving speaker with a decorator-designed table. The combination results in a novel conversation piece for your living room, and no one would suspect that your table is part of your sound system until you "turn it on."

Basically, the table holds an omni-directional speaker, from which sound is radiated over 360 degrees through the six side panels in the table. The panels, covered with the upholstery or drapery material of your choice, are the speaker grilles.

To make the unit even more attractive, decorative molding is used to trim all edges —available from local lumberyards. Construction is simple, and other than a power table saw, only hand tools are needed.

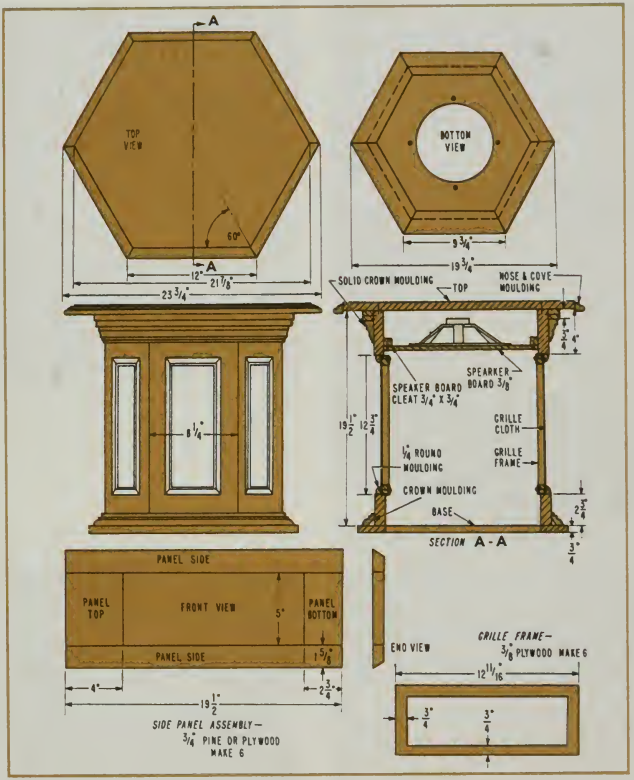
Use either ¾-inch pine or plywood for all major units, unless otherwise specified. Cut out the pieces for the six side panels, and assemble with finishing nails and glue. After the glue has set, sink nail heads about ⅜-inch below the surface, as panel edges must be trimmed at an angle on the table saw. A bit of masking tape wrapped around the nail set makes a useful depth gauge.

Set the table saw blade at a 30° angle,



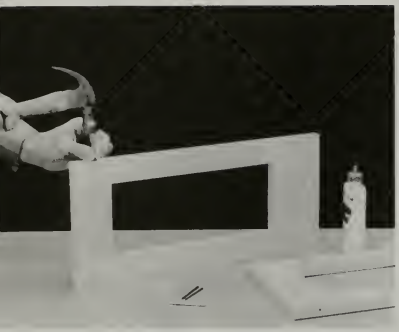
and trim each edge of the six side panels. Be sure to trim as shown in the drawing, so that each panel has a wide front face, a narrower back face. Sand all joints to eliminate any minor inaccuracies. Use a sanding block, or an orbital or straight-line power sander.

Make up a set of three clamping jigs. Clamp and glue the side panels together, one joint at a time. Put enough pressure on



the clamps to squeeze glue from the joint, but don't overdo it. A photo shows the clamping jigs in place, and the C-clamps that will be used to apply the pressure.

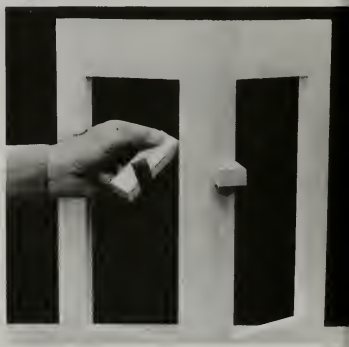
Cut out the six base pieces with their mitered corners and glue and nail them in place on the bottoms of the side panels. Install the crown molding around the bottom. Note: when mitering the corners of the molding, it must be supported at the same



▲ *Cut lumber for side panels, assemble with glue and nails. Clamp together until glue sets.*

▲ *Long edges of side panels will be trimmed and beveled, so after the glue has set sink the nails 3/8-inch below surface. A piece of masking tape on the nail set will serve as a depth gauge.*

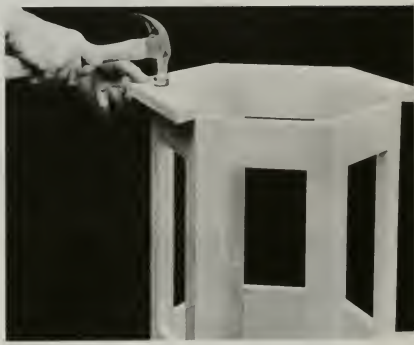
▲ *Sand the side panels, using a sanding block, being sure to correct any minor inaccuracies in the joints.*



➤ *Make six clamping jigs of scrap wood to hold the mitered joints together while the glue is setting. Glue one joint at a time. Use enough pressure on the C-clamps to squeeze glue from the joint, but don't overdo it.*

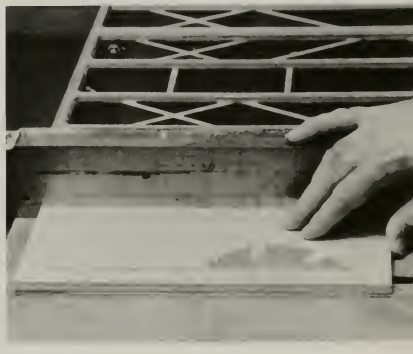
With glue applied to the mitered joint, the pieces are clamped together. Use three sets of jigs and three clamps per joint.

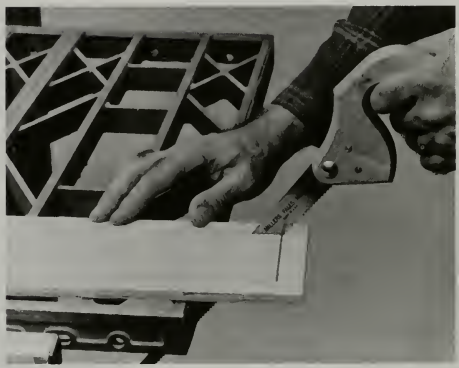
The base is made with mitered pieces assembled with nails and glue. The assembly is upside down in this photo.



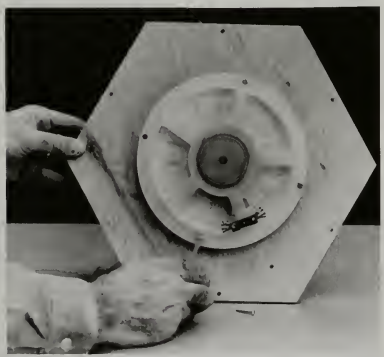
The edge of the table top is "shaped" with $^3/_4$-inch nose and cove molding.

Make blind cuts for the grille cloth panels with a table saw or handsaw.



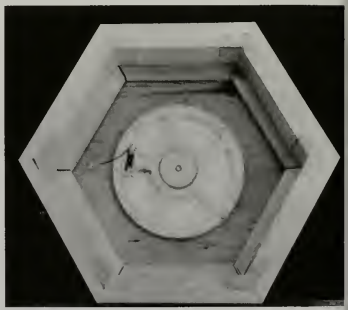


Finish blind cuts in grille cloth panels with a handsew.



Speaker is screwed to 3/8-inch plywood speaker board.

View of installed speaker looking down from top before table top was installed. Wires are soldered to speaker terminal and led through hole in speaker board to the base and ultimately to radio or hi-fi set.



angle that it will take when installed on the table.

Install the ¾ x ¾-inch pine strip around the top edge of the table, and the crown molding under it. Again, all joints are carefully mitered. Now cut out and install the quarter-round molding pieces along the inside edges of each side panel. These corners also are mitered for a neat appearance. This molding is simply glued in place to

MATERIALS LIST

Quantity	Size and Description	Purpose
6	3/4" 2 1/8"x10" pine or plywood	base
12	3/4" 1 5/8"x19 1/2" pine or plywood	panel sides
6	3/4" 4"x5" pine or plywood	panel tops
6	3/4" 2 3/4"x5" pine or plywood	panel bottoms
6	3/4" 3/4"x9 1/4" pine	filler strips
1	3/4" 19 1/2"x22" pine or plywood	top
6	3/4" 3/4"x7 1/2" pine	speaker board cleats
1	3/8" 12 3/4"x14 3/4" plywood	speaker board
1	3/8" 5"x12 3/4" plywood	grille panels
	1 1/2"x5' crown molding	
	1 5/8"x5' solid crown molding	
	3/4"x6' nose and cove molding	
	1/2"x18' quarter round molding	

NOTE: Also need grille cloth, finishing nails and white glue.

keep nail holes to a minimum. Masking tape can be used to "clamp" the molding in place until the glue has set.

The top panel is cut to size. Its edge is "shaped" with 3/4-inch nose and cove molding. It is not permanently installed at this time.

Six grille panels are cut from 3/8-inch plywood stock. Use the table saw to cut for the openings in each. Make blind cuts, starting and stopping just short of the cutting line ends, then use a handsaw to finish the cuts and drop out the center section. Staple or glue the grille cloth to each panel. Grille panels then are glued in place, after the speaker board is in place, behind the quarter-round molding in each side panel.

Glue and nail the speaker board cleats in place as shown. Cut out the speaker board itself from 3/8-inch plywood. Be sure to cut an opening in it the proper size for the speaker. Mount the speaker on the top face of the board.

Turn the table upside down, and lower the speaker board into place against the cleats. Be sure to turn the speaker board upside down, too. Drill pilot holes, and fasten the board in place with screws. This will permit its removal for service.

A pair of wires soldered to the speaker terminals are led through a hole in the speaker board down to the base of the table, where they can be led out through a small hole.

With the table upright, set the top panel in position, and center it carefully. It is fastened in place with glue and finishing nails. Go over the entire job, and set all nail heads slightly below the surface. Fill with plastic wood, and sand flush when this has dried.

Finally, give the table the finish of your choice: paint, varnish, or one of the "antiquing" finishes. Hook up the speaker wires to your radio, phonograph, tape recorder, or amplifier, and the project is complete.

Original design by Steve Ellingson.

See also: CLOCKS; ELECTRONICS; WOODWORKING.

WHERE TO FIND IT

If you are unable to obtain a suitable speaker from a local source, write to The Armor Co., P. O. Box 290, Deer Park, N. Y. 11729 for information about Speaker P-88 used here.

Bring Your Hi-fi Sound Outdoors with an Extension Speaker

A sturdy redwood planter box serves as the cabinet for an outdoor extension speaker

Your redwood planter comes completely assembled, ready to be turned into one great indoor/outdoor speaker. Sounds great, too!

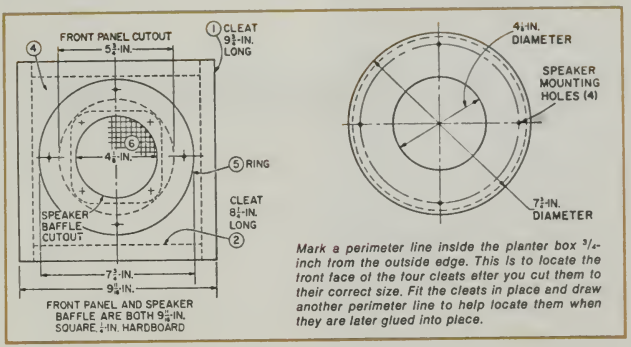
ONE TYPE OF BOX that is suitable for a speaker enclosure can be found in your garden nursery store. The redwood planters. They are sturdily built to hold soil for a number of years. Redwood is less susceptible to warping than other forest materials, and planter boxes are usually made of ¾-inch board securely joined. The planter employed for the speaker shown here has side walls that are $^{5}/_{16}$-inch thick, and the bottom is a ¾-inch solid board. Inside dimensions are 9¾-inch square by 6-inches deep. About an inch of the depth is lost when speaker mounting pieces are installed, but a sufficient volume of about 480 cubic inches remains available for the speaker.

Construction. It is a good idea to inspect the inside areas of the box to determine if there are any crevice openings along the inside corners. Seal these openings by running a bead of caulking full length along all the mating surfaces. Silicone rubber is ideal for this purpose, though other non-hardening caulking may be used. It is important that a speaker enclosure be made air-tight to insure adequate low frequency sound.

Pencil-line the perimeter inside the box ¾-inch from the edge of the open end with an adjustable square. This will locate the front face of the cleats after you cut them to length. Fit the cleats in place for a snug fit. Then pencil-line the perimeter once more using the inside edge of the cleats as a guide. These locator lines are a help when you are ready to glue the cleats in place. Plastic resin glue is the best bonding agent for this purpose, it is stronger than the wood when dry. You will find sufficient room to drive one inch long nails through the cleats to compress the glued joints and hold them in place.

All planter boxes have at least one drain hole in the bottom. Install a terminal strip over the hole and caulk this opening on the inside after a length of speaker hookup wire has been installed. However, if you intend to use the speaker outdoors, it is best to plug the drain hole with a wood dowel or a cork. Then designate a side as the underside and drill a ¼-inch hole about two inches from the open end for hookup wire.

Standard ¼-inch hardboard is ideal for mounting the speaker to the front face of the planter. This material has a smooth flat surface on the front and a waffle-like pattern embossed on the back. Note in the photograph that the speaker is mounted

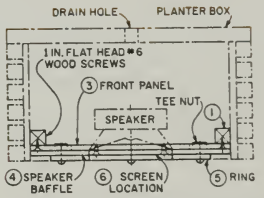


Mark a perimeter line inside the planter box ¾-inch from the outside edge. This is to locate the front face of the four cleats after you cut them to their correct size. Fit the cleats in place and draw another perimeter line to help locate them when they are later glued into place.

with three parts—front panel, speaker baffle, and a front facing ring. Mark the hole locations and cut-outs on the smooth face and make the cuts. Your front panel should make a snug fit inside the box, but your speaker baffle should fit loosely in the opening. It is a good idea to clamp these two parts together when drilling the four outside mounting holes. Then, all four holes in the front panel should be redrilled to fit the tee nuts.

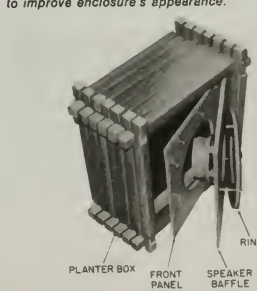
Speaker mountings. Locations for the four machine screw holes in the speaker baffle should be templated from the speaker's frame with the speaker centered over the 4⅛-inch diameter cut-out, while holes in the ring can be templated from the four holes in either the front panel or the speaker baffle. The flat heads of the screws should be flush with the surface of the hardboard. When assembling these parts note that tee nuts are pressed into place on the embossed side of the front panel. The front panel is then glued and screwed to the cleats (embossed side toward cleats). Your speaker is back-mounted to the smooth surface of the baffle. This provides a seal without the use of a gasket. Note that the speaker baffle covers all of the flat head wood screws in the front panel. The ring has been added for esthetic reasons, to cover flat head screws and bolts and to secure the fiberglass cone protector screen. Only four round head screws are exposed at the front.

Before the front panel is permanently installed, fill the inside cavity with 5 layers of



Planter box drain holes should be plugged to prevent turning your enclosure into a bird's nest if you put it to use outdoors.

Fan-out view of front area illustrates how simple construction really is. Front ring is added to improve enclosure's appearance.



MATERIALS LIST

Quantity	Size and Description	Purpose
2	3/4" 3/4"x9 1/4" fir	cleats
2	3/4" 3/4"x8 1/4" fir	cleats
1	1/4" 3'x3' Masonite hardboard	front panel and speaker baffle
1	1" 4'x4' fiberglass damping material	
1	12"x12" grille cloth	
4	8/32 tee nuts	
4	8/32 1/2" flat head machine screws	
4	8/32 nut and washers	
10	#6 1" flat head wood screws	

NOTE: Also need redwood planter and wide range speaker.

one-inch fiberglass. The front two layers should be cut out in the center to clear the magnet structure of the speaker. High compliance speakers operate most efficiently in small enclosures when damped with fiberglass.

For ease of handling or support for hanging the speaker, predrill a hole, centered on the top surface, to receive a 1/8-inch screw eye, or install four small screw eyes since wire hangers are usually furnished with the planter.

Sound source. Dimensions given in the drawing will fit a 4-inch Altec 405A. There are several high compliance 4 or 5-inch full range speakers available that can be expected to operate with satisfaction in this application. However, the Altec speaker is recommended for this system if it is to be used outdoors. High efficiency in a speaker is very important when it is necessary to connect it at a location that is likely to be up to 125 feet from the source of audio power. Do not use antenna lead-in wire; the wire size is too small. A 1/4-inch diameter #16 gauge vinyl-jacketed cable is recommended for outdoor cable runs. It may be used up to 125 feet with less than 15 percent loss of audio power.

Tie a knot in the cable or build up its diameter by tightly wrapping rubber tape about a foot from the end, then solder the speaker terminals and caulk the inside where the cable enters the enclosure. Push the baffle-speaker assembly into the front panel opening and insert the four round head screws and tighted them.

Optional finishing. If the speaker is to be used outdoors, it is advisable to give all of the hardboard pieces a coating of resin sealer. A pleasing front appearance can be had by coating the embossed surfaces of the speaker baffle and the ring with a color-toned penetrating sealer to match the prefinished planter. If the redwood color is not appealing, you can paint-decorate all of the outside surfaces, or give it a coating of charcoal resin sealer to obtain a dark, woodsy finish. H.F.J.

See also: CLOCKS; ELECTRONICS; HIGH FIDELITY SYSTEMS; SPEAKERS.

WHERE TO FIND IT

The redwood planter used here is distributed to garden nurseries by Germain's, Inc., 4820 50th Street, Los Angeles, Cal. 90058.

For information about the Altec 405A 4-inch wide range speaker used here, write to Altec-Lansing, 1515 South Manchester Avenue, Anaheim, Cal. 92803.

Four Ways to Build with Stone

The materials are inexpensive—some of them are free. All it takes is muscle, ingenuity and the time to learn the techniques and you will be able to erect walls that will enhance the beauty of your home, both inside and out

A wide range of forms and types of stone offers the homeowner many opportunities to use this material in building walls that are decorative and need little maintenance.

ALL YOU NEED TO WORK with is to have a little ingenuity and muscle and choose rocks that are as big or bigger than your fist and don't crumble in your hands.

You can shape the stone with a claw or ball peen hammer, or split it with a hammer and cold chisel or a stone mason's hammer. Other tools you'll need when working with stone are a level, tape measure, and trowel, plus a pair of heavy gloves to handle stone and cement.

Whether the stone is cut at the quarry or on the job, professional stonemasons usually soften or work the stone by chipping off the square corners. Hold the stone on your thigh so the muscles cushion the blows enough so the edges won't split off more than you want them to. Another way is to shape the stone on a bed of sand or cushion the stone with a sack filled with fine sand.

Cut stone walls. Cut stone can only be made from rock that has a pronounced grain so it will split into layers.

The pattern of laying up cut stone is either random or coursed. Random means that all the joints are either vertical or horizontal, although they do not have to run continuously either up or across. When coursed, the horizontal joints are continuous.

Plan the wall so it rests on a solid footing. When the stones are laid in mortar, the footing should go below the frost line (at least 36 inches below the surface) and extend out not less than 4 inches on each side of the wall. If there is adequate drainage, the footing does not have to go below the frost line because the water will drain away and not get under the wall to freeze. You can provide for drainage by backfilling with cinders or gravel.

Cut stone walls can only be made from rock that has a pronounced grain so it can be split into layers with a hammer and cold chisel.

Chipping off the sharp corners tends to soften the exposed surface and enables you to recess the mortar line so that joints look uniform.

Tool the mortar joints with a bent conduit pipe to fill in any openings and give the joints a smooth finish.

Plywood forms nailed between the frame studs hold the mortar so it can set around the frame and give added support to the stone wall.

Once the footing for the wall is set, establish a fixed point or line on the footing and build from there. Keep the wall plumb by using the level to check each layer of stone. On long runs use a string to keep the face-line straight. Use your tape measure to maintain an even depth or thickness.

Mortar for laying up the cut stone can consist of two or three parts of plaster sand, one part of cement, and one part lime. Lime doesn't have to be used, but it makes the mortar more plastic. After laying up several stones, run a bent ½-inch conduit along the mortar joint to give it a smooth finish.

Build the wall against a wood form if you are going to use stone for the exterior wall and want to finish the inside surface with another material. Pour the footing and fill the space between the footing, stone, and wood with concrete. For a sturdy wall, imbed ⅜-inch reinforcing steel rods in the

By laying the flat surface of the stone against wooden forms, you can trim the surface so it looks like cut stone and erect the wall with less mortar and stone.

space between the wood wall and stone at intervals of 12 to 18 inches.

Rubble walls. This type of wall lends itself to stones that are rough and irregular and relies on mass for its attractiveness. Stonemasons call this type of wall "random rubble lay." Large stones are rolled into place and the cracks and V-gaps between them are plugged with smaller stones and cement.

The only tool you need for this type of construction is a shovel to dump in the mortar. Wear gloves when you pack mortar in the joints where extra fill is needed, because the cement will take all the oil out of your skin and cause it to crack or peel.

This type of wall can be built by eye. If, however, you are uncertain about the accuracy of your vision, stretch a guide string from time to time to check the straightness and use your level to verify the vertical position.

Random rubble walls usually require considerable stone and cement, but stonemasons get around this by using forms for one or both sides to reduce the thickness by half or more. This fireplace was built that way.

If any veneer stones show a tendency to loosen before the cement sets, drive nails around the edges so the nail heads grip and hold the rock. The nails will be covered when you point up between the stones with grout.

After the wall is erected, use a rich grout to fill in any openings between the stones.

The best mortar mix to use is three or four parts coarse sand to one part cement. You can add one part lime for greater plasticity, but in this kind of wall strength is more important than plasticity.

Random rubble walls must be thick to be effective. A wall 8 feet high should be from 16 to 24 inches wide at the base. The mass appearance of this wall makes it useful for such things as retaining walls, plant pocket, and fireplaces. You can build a single wall of this type in your house to give it a feeling of solidness.

Formed walls. Random rubble walls usually require considerable stone and cement, but stonemasons get around this by using forms for one or both sides to reduce the thickness by a half or more. The fireplace shown was built that way.

Build the form one board at a time as you lay up the wall. Be sure the form for the exposed surface side is straight and solid so the finished surface will have the appearance of cut stone.

After the form board is set in place, lay the flat surfaces of the stone against it and fill the openings with mortar. Don't try laying up too much wall before giving the cement a chance to set. A 2-foot high row of stone is enough for one day. After the cement has set, remove the forms and finish the joints between the stones with a fine grout. This grout mix is made up of two parts plaster sand and one part cement.

Another method of building stone walls for a house is to erect the interior and exterior walls around the stud frame. In this type of construction it is best to ask your building materials dealer or contractor what size the footing must be to support the size of wall you want to erect.

The forms used for this project fit between the studs. Take the inside measurement between two studs and cut a sheet of ¼-inch plywood to this dimension. Nail the edges of the plywood to 1 x 2s and position the frame between the studs so the 1 x 2s butt against the studs and the exposed ends of the firring strips are flush with what will eventually be the inside wall of the house. Use scaffolding nails to attach the form to the studs.

When laying up the stone for the exterior wall, be sure the mortar is against the plywood and around the studs. The plywood forms can be removed once the cement sets up. Fill the space between the interior and exterior stone walls with cement or insulation.

Rock veneer. This material can be purchased from a quarry or stone distributor in irregular shaped slabs that are ½- to 1-inch thick and give a house a solid stone look. A ton of this stone will cover about 240 square feet of wall, and with the mortar will weigh about 10 pounds per square foot when installed.

Before you cover an inside wall with stone veneer, be sure the foundation can hold the increased weight. If there is any doubt, brace the joints with 2 x 6s set on concrete piers or ceiling jacks spaced every 4 feet.

The surface you are going to veneer should have studs spaced 16 inches on centers and covered with wood or plywood sheathing nailed every 2 inches with 8*d* nails. Cover with heavy weight building paper and staple 1-inch mesh chicken wire over it. Use a rich grout, two parts fine sand to one part cement, for adhering the veneer. Butter the back of each slab liberally with mortar and push it over the mesh.

If you are going to veneer the lower part of an outside wall the top edge of the stone surface must be even and well sealed. Caulk the edge and fill any openings that might exist between the stone and the frame surface, then fasten a beveled wood drip strip over it to prevent water from getting behind the stone. P.A.C.

See also: BRICKWORK; HOME IMPROVEMENT; MASONRY.

How to Install Curbs, Edging and Ground Cover

Use these easy, inexpensive methods to beautify your garden, patio and lawn

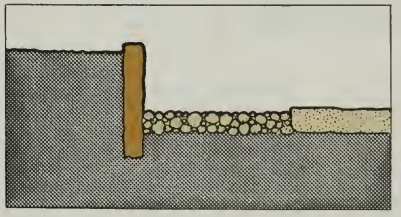
STONE CURBING, EDGING AND ground cover can beautify your garden, lawn or patio as well as mark off one zone or area from another.

Many shapes, colors and textures of stone are available for these uses at a variety of prices. Consult your dealer to find out what's available in your part of the country and the cost.

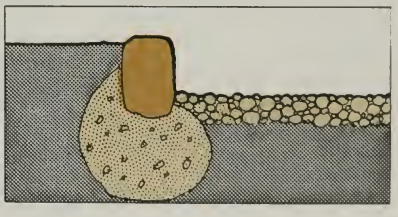
Stone curbing or edging can be set in dry soil or it can be set in concrete.

The simplest, but least sturdy method is to set it dry. Just set the stone in a slightly excavated trench and pack dirt around it, keeping the stone level and erect.

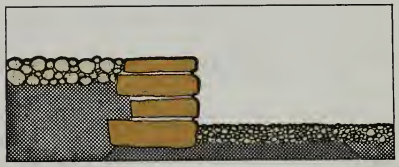
The wet method using concrete requires a larger trench, into which is poured a mixture of one part cement, two parts sand and four parts gravel. The curbing is set in the wet concrete mixture so that no concrete is allowed to show. If there are visible joints, fill them with a mortar made of one part cement, three parts sand and sufficient water to make the mixture workable.



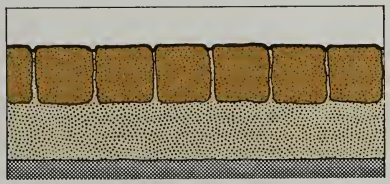
Linear strip curbs can be simply set in the ground, as shown here.



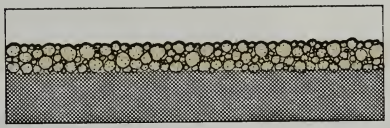
This method can be used to set curbing in concrete. The concrete is poured and shaped so it doesn't show.



Layer type curbing can be set with or without mortar.



Set paving blocks for walks or patios on a four-inch thick bed of sand. Fill joints between blocks with sand.



For a soft surface, just spread an aggregate of pebbles or stone chips over a surface with a rake. Aggregate can be bought by the 100-pound bag or by the ton.

A layer type curb, built up of long, flat stones, is like a mini-retaining wall. These require no mortar, but if you wish, you can set the stones in a mortar mix.

Stone ground cover can be either paving blocks or aggregates of pebbles or chips.

Use blocks where there will be heavy foot traffic, such as a patio or walk. Simply set the blocks on a 4-inch-thick bed of sand, keeping the blocks as closely spaced and level at the tops as possible. Fill the joints with sand.

An aggregate of pebbles or chips forms a softer surface. It can not stand a great deal of foot traffic. It is used widely in garden areas where a decorative effect is required, but the firmness of a walk or patio surface is not needed.

Generally, these materials are simply poured over a hard dirt surface and spread with a rake. Sometimes, plastic sheeting is put down beneath the aggregate to keep weeds from growing through it.

Aggregates are sold in 100-pound bags or by the ton. See the accompanying chart to determine what quantity of pebbles or chips is required to fill an area.

See also: CONCRETE; CONCRETE BLOCKS; GARDEN PLANNING; HOME IMPROVEMENT; LANDSCAPING; MASONRY.

AGGREGATE COVERAGE

Thickness	Square Feet Per 100 Pounds	Square Feet Per Ton
1 in.	8-10	160-200
2 in.	4-5	80-100
3 in.	2-3	40-60

What You Should Know about Retaining Walls

Simple, sturdy and easy to build, these walls can beautify your property as well as protect it from erosion

RETAINING WALLS CAN beautify your property as well as protect your landscaping from erosion.

Building suppliers in various parts of the country have a great assortment of stone available—granite, limestone, marble, slate, quartzite are some examples—at varied prices and in many different colors and textures.

The walls themselves are not difficult to build. A dry wall, in which no mortar is used, is the simplest. In a wet wall, the stones are bonded together with mortar. This type is stronger, but requires more work to construct.

One factor that makes a dry wall easier to build is that it requires no excavation to bring the footing down to the frost line. The wall, since it has no mortar, gives slightly as the soil rises and subsides with frost.

Simply dig a wide trench about six inches below grade for the base of the wall. At the back of the trench—it will be behind the wall when the wall is built—install a continuous drain surrounded by course gravel.

Lay the first course of the wall in the front of the trench, using the largest stones. Lay the stones for this course and all others as they would lie on the earth. Do not set any on end.

When the first course is completed, stake a string along the wall to use as a guide.

Retaining walls higher than two feet require an inward slope, toward the back of the wall. This slope is called a batter. Generally, dry retaining walls are built with a batter of 2 inches per foot of height.

To construct the batter accurately, make some batter boards. A batter board is simply a board that is straight on one long edge and slanted on the opposite edge in the same amount as the batter of the wall.

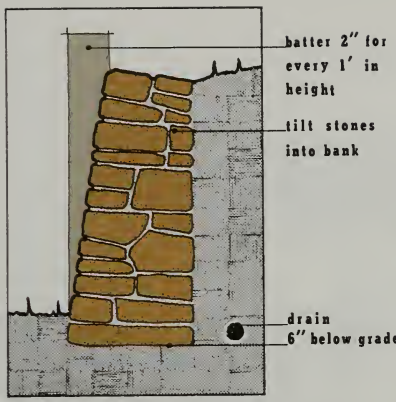
Drive the batter boards into the ground, using a plumb to keep the straight edge vertical. The sloped edge next to the wall will serve as a batter guide as you build the wall.

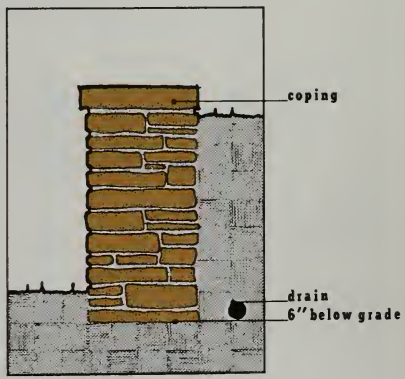
As the wall rises, pack earth into the back, and use long stones to tie it to the soil behind it by letting them stick out from the back of the wall.

Avoid joint lines. If the spaces between some of the stones form continuous lines in any direction, rearrange the stones. Joint lines are unattractive in appearance and weaken the wall.

Walls that are less than two feet high do not need a batter if they are not required to hold back too much earth. Generally, the top of a low wall requires the protection of a stone coping. The coping also improves the appearance of the wall and can be used for that reason on a high retaining wall as well.

Building a wet wall is something like building a dry wall, but there are some





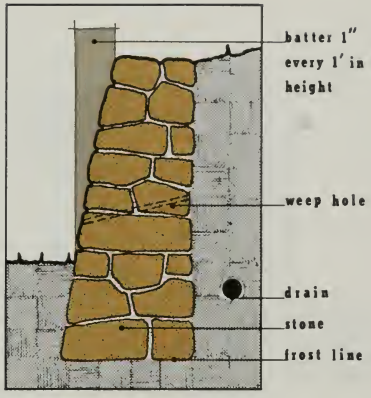
▲ *Two types of dry retaining wall. Walls higher than 2 feet require a batter—an inward slope of the face. However, walls less than 2 feet high can be vertical.* ➔

differences. In a wet wall, mortar is packed between the stones. This means the wall is solid and its base must be at the frost line. In addition, weep holes must be built into the wall to release water trapped in the soil behind it.

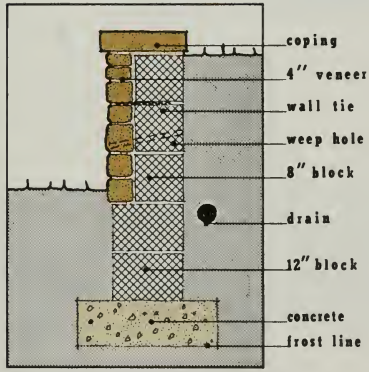
The advantages of a wet wall are that stones will not get kicked or bumped out of it, as occasionally happens in dry walls, and earth will not run through it.

Generally, start a wet wall as you would a dry wall, except that you must lay the first course at the frost line, or on a poured concrete footing that starts at the frost line.

The batter of a wet wall is only 1 inch per foot of height.



Two ways to build a wet retaining wall. Since the stones of the wall are bonded with mortar, the base, or footing, must be at or below the frost line. Also, weep holes must be built in.

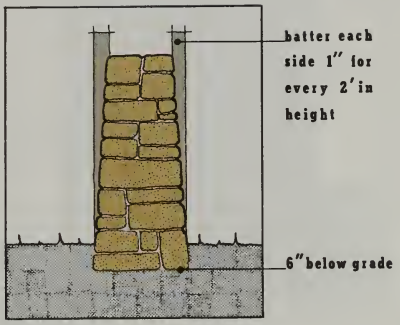


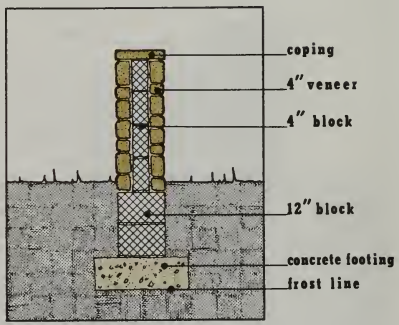
To mix the mortar, use one part cement, two parts sand and as much water as necessary to make the mortar workable. Fill all voids between the stones with mortar.

The continuous drain of the wet wall does not have to be at the frost line, but it should be slightly below grade.

One way to save money, if you are using relatively expensive stone, is to build the wall of cinder block and apply a stone veneer to the face.

The footings and continuous drain are the same as for any other retaining wall. Build the cinder block wall on the footing up to a few inches below grade. Leave a 4-inch shelf there and continue the cinder block





Principles used in building retaining walls can be used in constructing free standing walls.

wall to planned height, but make it four inches thinner.

The shelf and the thinner upper wall provide space for the stone veneer. Use wall ties as you lay the thinner upper section to bond the veneer to the wall. Also, insert rust-free metal pipe sections through the wall to serve as weep holes. When the cinder block portion is complete, lay the stone veneer and cap the wall with a coping to protect the veneer and cover the open tops of the cinder blocks.

You can use the same principles to construct free standing walls. Just think of it as a two-faced retaining wall and eliminate the drains and weep holes. If you are building a dry wall, batter each side 1 inch for every two feet of height.

See also: BRICKWORK; CONCRETE; CONCRETE BLOCKS; HOME IMPROVEMENT; MASONRY.

Storage Unit for a Folding Bed

This unit, suitable for guest or child's room, also serves as a desk

THIS ATTRACTIVE FOLDING BED storage built-in also serves as a bedroom desk, bookshelf and countertop. Ideal for youngster's room or guest room, dimensions can be altered to suit varying bed sizes, so you can custom-build a storage unit to hold the bed you own.

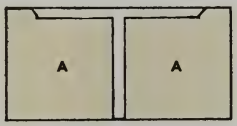
Begin by laying out two 4 x 8-foot panels of ¾-inch plywood as shown in the diagram. (Plan gives dimensions for a built-in to store a bed that when folded measures 18 inches wide, 42 inches high and 40 inches deep.) Use a large carpenter's square for accuracy, and remember to allow for saw kerfs between parts. Next, cut out the pieces with a hand or power saw and true up any irregularities along the edges with a coarse sanding block.

Construct the body of the unit as you would a box, by gluing and nailing all joints. Fasten the end panel between the side pieces, then insert and fasten the top. Position the unit against the wall of the room, cutting out a section of the baseboard so the unit fits tightly. Fasten the assembly securely with heavy screws driven through the back panel into the studs. Next, make the special metal fitting—a length of brass, aluminum, or steel angle stock cut and bent to anchor the front of the unit. Screw the anchor to the floor and to the sides of the built-in.

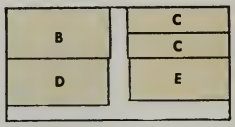
Note that the desk is shorter than the sides of the built-in to allow the door to swing back 180°. Mount the desk with brackets cut from 1 x 4-inch lumber. Then fit the doors, allowing at least ¼-inch bottom clearance. Hang the doors with either pin-type or mortised butt cabinet hinges, and supply suitable pulls and catches. After filling nail holes and plywood edge grain with

filler, sand the unit smooth and finish it to match the room decor. A three-coat paint job is recommended for best results—an undercoat followed with two coats of finish color. Sand each coat lightly before applying the next.

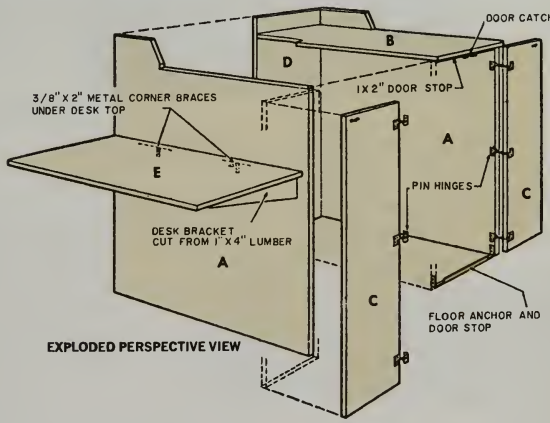
See also: BEDS; DESKS; FURNITURE, INDOOR; ROOM DIVIDERS; STORAGE WALL.



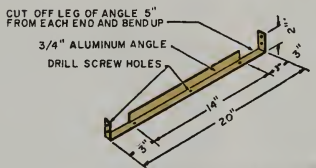
3/4" X 4'-0" X 8'-0" INT.-DFPA-A-D



3/4" X 4'-0" X 8'-0" INT.-DFPA-A-D

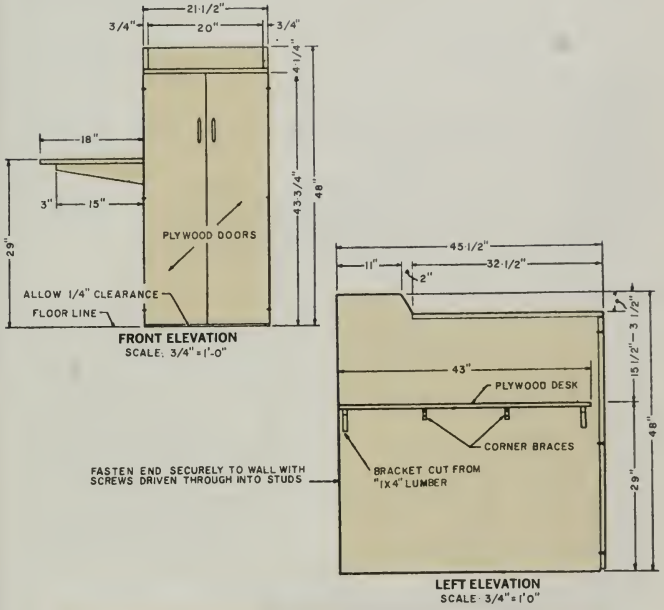


EXPLODED PERSPECTIVE VIEW



DOOR ANCHOR AND DOOR STOP DETAIL
NOT TO SCALE

Storage Unit for a Folding Bed 2533



MATERIALS LIST

Quantity	Size and Description	Purpose
2	3/4" 43"x45 1/2" fir plywood	sides
1	3/4" 21 1/2"x44 3/4" fir plywood	top
2	3/4" 10 3/4"x43 1/2" fir plywood	doors
1	3/4" 20"x43 3/4" fir plywood	back
1	3/4" 18"x43" fir plywood	desk
1	1" 2"x2' stock lumber	door stop
1	1" 4"x2' stock lumber	desk brackets
1	3/4" 3/4"x2' metal angle	floor angle

NOTE: Also need pin hinges, door pulls and catches, corner braces, 6d finishing nails, screws, glue and finishing materials.

Food Storage Unit

That awkward area beneath the stairs becomes useful storage space with this functional built-in design

STORAGE SPACE in the kitchen is always at a premium, especially if you like to buy food in large quantities to take advantage of sale prices. This food storage center, designed so that it will fit into a most remote area of your basement, will help you organize your budget and also allow you to stock up the most necessary items for the proverbial rainy day.

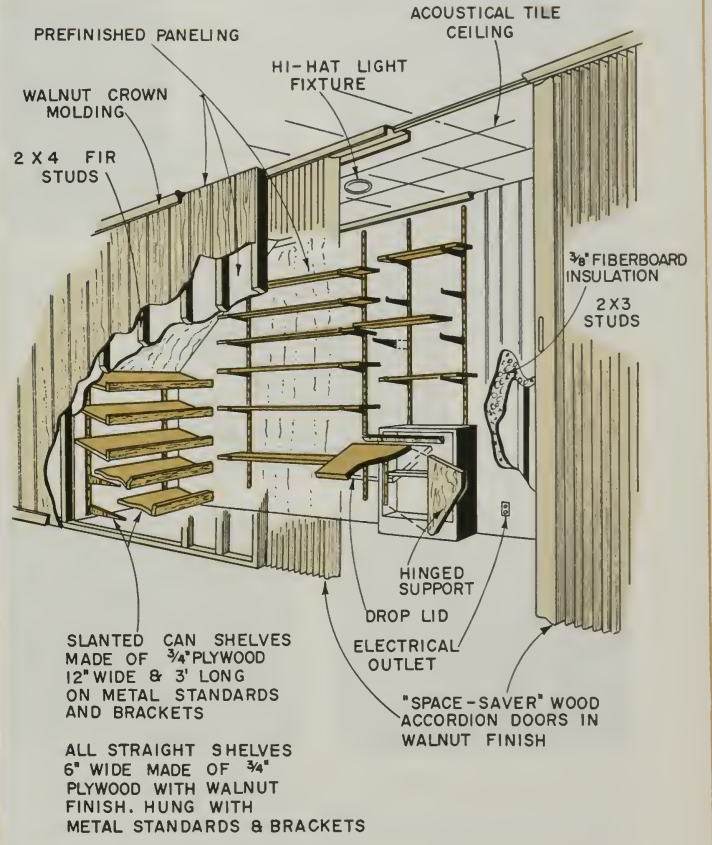
The area under a staircase is usually hard to utilize, and that's where this unit is built. In the lowest section beneath the staircase, a vertical wall is erected, against which shelves are mounted on slanted brackets. These shelves have front strips on them so that they can be used for canned goods storage, as is done in many food markets.

The front wall, which ends about 30 inches from the freezer, has straight adjustable shelves on the inside, as does the opposite wall. Two feet of this wall were utilized for a folding cabinet-table top combination, which comes in handy when food is gathered up. On the opposite end of the compartment, next to the freezer, is a broom and mop storage rack.

The entire unit is covered on the inside as well as outside with pre-finished panel-

Straight shelves are against the wall. Slanted shelves may be seen in the background.

Food Storage Unit 2535


PREFINISHED PANELING
ACOUSTICAL TILE CEILING
HI-HAT LIGHT FIXTURE
WALNUT CROWN MOLDING
2 X 4 FIR STUDS
3/8" FIBERBOARD INSULATION
2 X 3 STUDS
HINGED SUPPORT
DROP LID
ELECTRICAL OUTLET
SLANTED CAN SHELVES MADE OF 3/4" PLYWOOD 12" WIDE & 3' LONG ON METAL STANDARDS AND BRACKETS
"SPACE-SAVER" WOOD ACCORDION DOORS IN WALNUT FINISH
ALL STRAIGHT SHELVES 6" WIDE MADE OF 3/4" PLYWOOD WITH WALNUT FINISH. HUNG WITH METAL STANDARDS & BRACKETS

A small cabinet with adjustable shelf was installed next to the freezer. A fold-down top was hinged to the cabinet.

A fold-out support on the cabinet will hold considerable weight. It can serve as an auxiliary counter when moving food to or from the freezer.

All shelves in the food storage unit are mounted on adjustable brackets.

Wood panel accordian doors are mounted to conceal the center.

A small space at the end, between the freezer and the partition wall, houses brooms and mops used in the basement.

ing, matching the rest of the finished basement.

To enclose and conceal the food storage compartment, walnut-finished wood panel accordion doors are used. These doors are easy to maneuver and enhance the finished appearance of the basement. They keep the food area dust-free and easy to maintain.

See also: ROOM DIVIDERS; STORAGE WALL; WINE CELLAR.

Store Your Small Appliances in a Hutch

Here's how to build a storage hutch that will keep your electrical cooking appliances organized and form a convenient working area

THIS ATTRACTIVE HUTCH not only provides convenient storage for your electric cooking appliances, but has its own work surface and electric outlets that make it an auxiliary cooking center—ideal for the family room, recreation room, or finished basement.

There is ample storage both above and below the work surface. A hinged door flips up to extend the work counter; when folded down it conceals a full-width storage space that's ideal for those long rotisseries or griddles.

The hutch is designed for easy maintenance, as it is finished inside and out with a washable paneling such as plastic-faced hardboard—over a plywood core. This type of construction provides exceptional strength as well as long-lasting beauty. Most washable paneling is available in 16-inch x 8-foot planks and in 4 x 8-foot panels; although plans here indicate use of a plain colored surface on the interior, and textured wormy chestnut paneling on the exterior, there's a wide choice of finishes so you can match any decor.

No special tools are required for this project, but use of a pair of bar clamps is recommended during assembly. The paneling itself is cut and installed in the same manner as plywood; use a fine-tooth crosscut saw, however, to avoid fracturing the plastic surface.

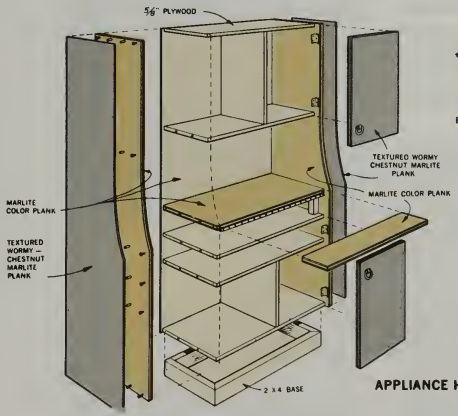
Begin by marking out the sides, doors, cooking shelf, and drop shelf on ⅜-inch plywood; cut and trim to size. Use the side and door units as patterns, and trace them on the back of the 4 x 8-foot panel. Allow an extra ¼-inch along the rear edge of each side panel, as this will lap over the edge of the back planks. Cut the pieces and trim to shape.

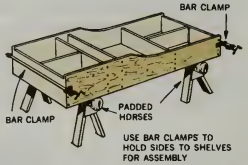
Trace the cooking shelf, drop leaf shelf, doors and a duplicate set of sides on the back of the colored planks. Note that it is necessary to add thin strips along the rear edges of these side pieces in order to get the full width. Also mark out the two back panels, and saw all the pieces to shape. Cut the rest of the shelves and dividers from ⅝-inch plywood.

Now glue the pieces that form the inner faces of the side pieces to the plywood side panels. Use contact bond cement for this. Coat both surfaces, and allow the glue to dry—it takes about twenty minutes. When the glue is dry, place a sheet of wrapping

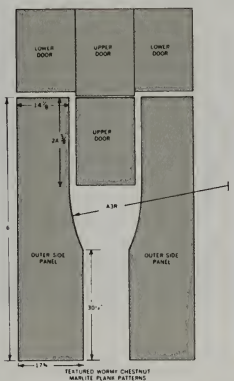
paper over the glue on the plywood panel. The paper must be slightly larger than the panel. Set the paneling in place, aligning it carefully with the plywood. When you are satisfied with the alignment, hold it in place, and have a helper lift one edge and slide out the paper. Remember: once the glue sets you won't be able to reposition the pieces.

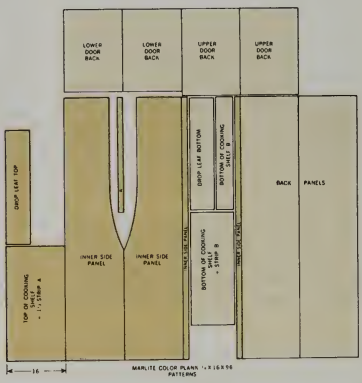
Use a rubber mallet, or a hammer and a block of soft wood, and tap down the paneling working from the center out to the edges. Follow the same procedure when it comes to the remaining pieces. Be sure to





APPLIANCE HUTCH ASSEMBLY





work in a well-ventilated area, as the glue fumes are toxic.

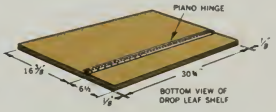
Apply the paneling to the door faces, cooking shelf and the drop shelf. Do not glue the outer side panels in place at this time.

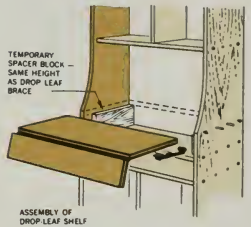
Make up the hutch base with the 2 x 4-inch stock. Miter the front corners, and glue all joints. Fasten at all corners with 6d finishing nails. It is suggested that the base be painted black, and it can be painted at this stage.

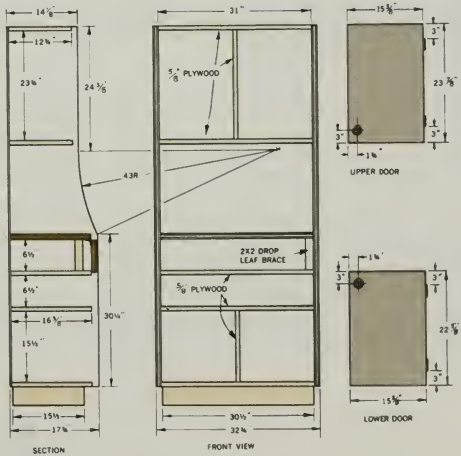
Drill and countersink holes in the top and bottom corners of each side panel. Glue and screw the sides to the top and bottom shelves, using bar clamps to hold the assembly together, as illustrated. Screw fasten the second shelf and divider in place, then the third and fifth shelves and the upper divider. Do not insert the cooking shelf yet.

Turn the assembly upside down to attach the colored planks that form the back. Naturally, the plastic face of the planks will be on the inside of the hutch. Drill small holes for 2d nails at 4-inch intervals along the sides, and top and bottom shelves. Mark carefully the location of center lines of the other shelves, and drill similar holes at 6-inch intervals along these lines. Be sure that everything is absolutely square, and nail the back planks in place.

Now turn the assembly face up and carefully drill ¼-inch holes 1½ inches deep through the sides into the shelves. Cut ¼-







inch dowel into 1½-inch lengths, coat with glue and tap into the holes. These provide considerable strength to the assembly. Be sure all the dowels are finished off flush with the surface of the plywood sides.

Attach hinges to the doors, place the doors in position on the hutch, and mark the sides for hinge locations. Remove the hinge pins and fasten the loose hinge leaves to the sides; replace the pins to attach the doors.

Stand the hutch upright on its base. Drill through the bottom shelf for six 1½-inch #10 wood screws, and fasten the hutch to the base.

Cut two spacer blocks, 6½ inches high from scrap stock, and place these against the side panels inside the hutch on top of the third shelf. Carefully trim the edges of the cooking shelf to just slide in place above these blocks. Turn the cooking shelf and drop leaf face down, and attach the piano hinge and drop leaf brace. Fasten the drop leaf brace block in place with two 1½-inch #10 screws.

Now slip the cooking shelf with drop leaf attached into place and fasten permanently with screws and dowels, in the same manner as the other shelves. Fasten the drop leaf brace to its block, and remove the temporary space blocks.

Be sure all screw heads are countersunk on the side panels, and all dowels are flush with or slightly below, the surface. Install the outer panels in the same manner as the previous panels. Do one side at a time, setting the hutch on the opposite side as each panel is installed.

Fill any voids along the front edges of plywood panels with wood putty or plastic wood, and sand the edges smooth. These edges can be painted to match the color panels, or black to match the base. An alternative is to cover the edges in flexible wood tape.

Inside plywood surfaces of shelves and dividers can be painted the color of your choice. If any paint gets onto the plastic surface, wipe it off before it dries.

To finish the project, add the two-foot plug-in electrical strip, magnetic door catches and door pulls.

See also: EARLY AMERICAN; FURNITURE, INDOOR; KITCHENS.

MATERIALS LIST

Quantity	Size and Description	Purpose
1	¾″ 4′x8′ plywood	sides, doors and drop shelf
1	¾″ 2′x4′ plywood	shelves
1	⅝″ 4′x7′ A-B plywood	bottom, top, dividers and movable shelves
1	¼″ 4′x8′ washable paneling	side and door exterior faces
6	¼″ 16″x8′ washable paneling	back, insides, shelves and door backs
1	2″ 4″x8′ clear pine	base
1	2″ 2″x6½″ clear pine	drop leaf brace
as needed	1½″ #10 wood screws	
1	¼″x3′ wood dowel	

NOTE: Also need offset brass hinges, door pulls, drop leaf bracket, piano hinge, magnetic catches, electrical plug-in strip, 8d finishing nails, 2d common nails, contact cement and black paint.

Divider Unit Combines Desk and Storage Space

This open, informal design is easy to construct and when you want to move it, simply knock it down and reassemble without difficulty

THE OPEN, INFORMAL DESIGN of the combination desk and storage unit makes it attractive but unobtrusive. You can install it at the end of a room or in a corner, or use it as a divider without overwhelming the rest of the decor.

The unit is not difficult to build and requires few power tools. A power drill, of course would make the work go faster, but accurate holes can be drilled by hand.

One power tool is a must. This is a saw, either a table saw or a portable circular saw, to cut out the parts accurately and to cut the dadoes in the magazine rack (unit A). The latter task could also be done with a router.

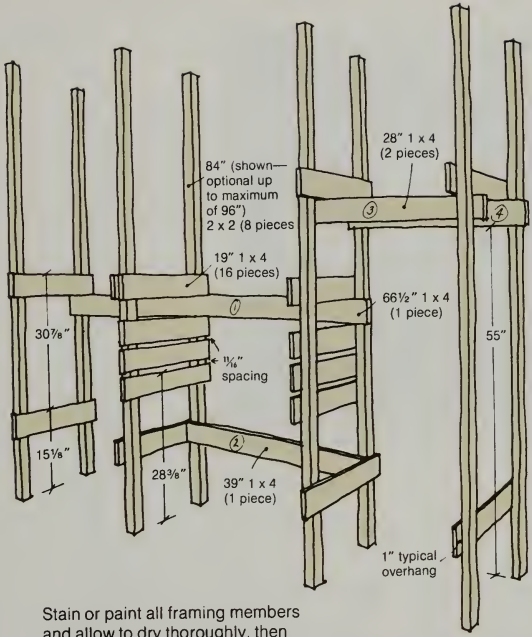
If you have no power tools, or don't want to do all the work yourself, have a carpenter build the modules. Then, you can assemble the unit yourself.

Layout the parts on plywood, as shown in the plans, and cut them out. True the edges with coarse sandpaper and, if necessary, fill any cracks with filler.

Next, cut the 2 x 2s and 1 x 4s to the dimensions shown in the drawing of the framing. If you wish, you can use the dimensions shown or you can extend the uprights to ceiling height.

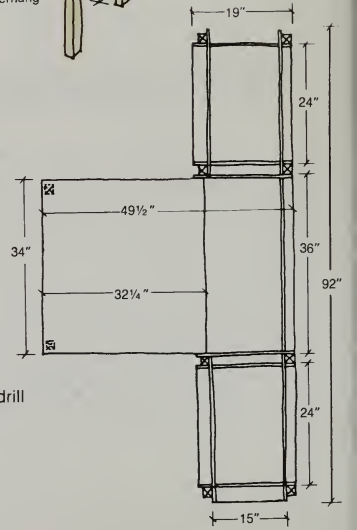
At the same time, cut the 1 x 4s for the drawer sides and backs and for the table edges. Sand all surfaces smooth and round the edges slightly.

Once the parts are ready, assemble the modules, following the step-by-step instructions in the plans. Do this in your work-



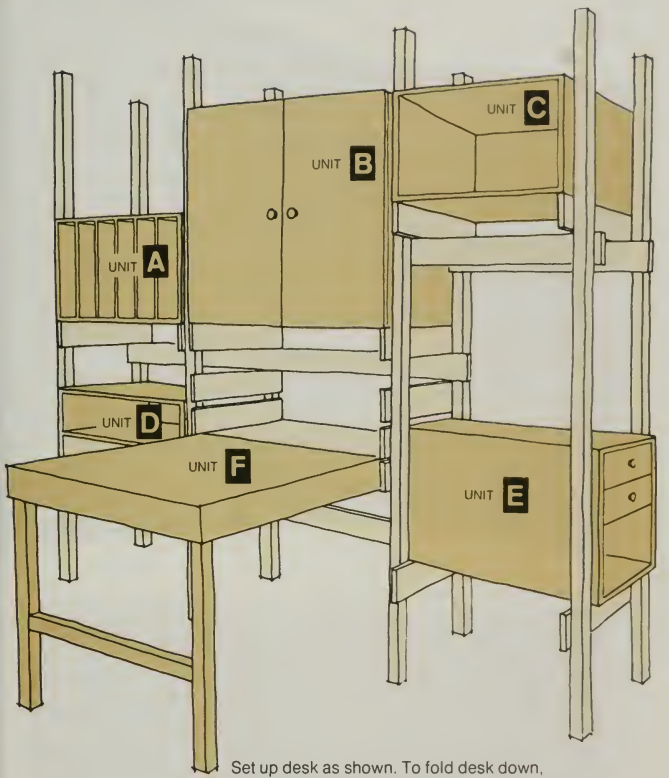
Stain or paint all framing members and allow to dry thoroughly, then move framing into room for assembly.

Predrill and screw together all 2 x 2 and 1 x 4 framing members, attaching members marked 1-4 last.



Mark screw hole locations (four per unit) on plywood unit modules where they will attach to 2 x 2 supports. Set unit modules in place, predrill into 2 x 2 supports and fasten securely.

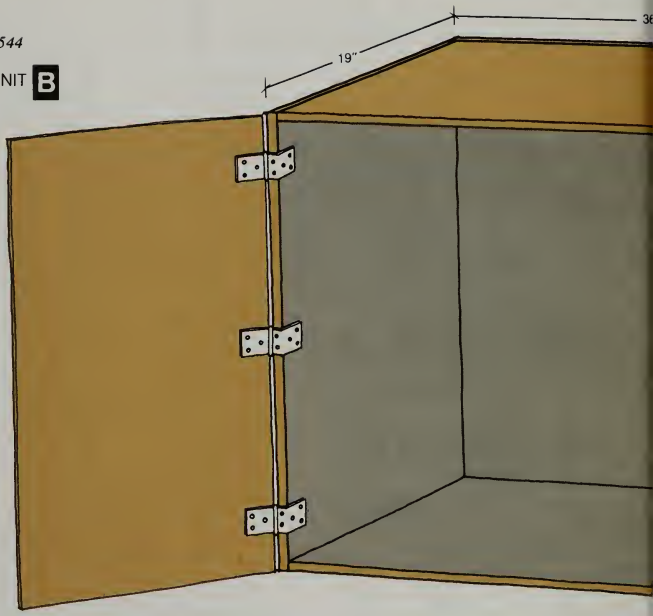
Divider Unit Combines Desk and Storage Space 2543



Set up desk as shown. To fold desk down, unlatch screen door hooks on legs, fold legs under and latch with screen door hook. Remove desk assembly from support framing and place assembly into channels directly above the previous channels. Desk top will fold down compactly without touching floor.

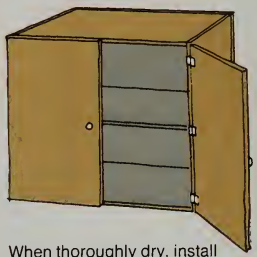
2544

UNIT **B**

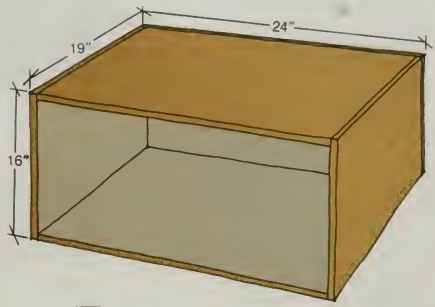


Glue and nail basic cabinet parts together, including the shelf. Countersink nail holes before glue sets, and wipe away excess glue. Fill nail holes, allow to dry, and sand smooth.

Drill holes (dia. as required) through cabinet doors for door pulls.
Mark location for door hinges on center of doors and 4" from top and bottom. Predrill screw holes. Sand sharp edges off plywood corners, then wipe entire unit clean, and paint.

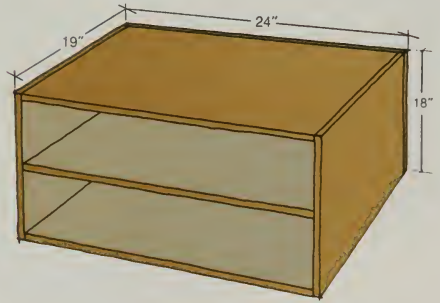


When thoroughly dry, install hinges on doors, and doors on cabinet; apply door pulls and magnetic catches.



UNIT **C**

Glue and nail parts together. (An extra shelf may be added; it's shown on panel layout as optional.) Finish as above.

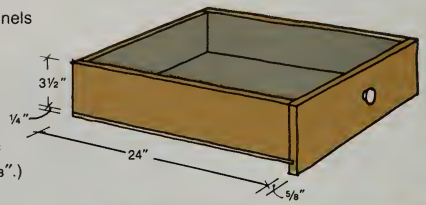


UNIT **D**

Nail and glue parts together and finish as above.

2546 *Divider Unit Combines Desk and Storage Space*

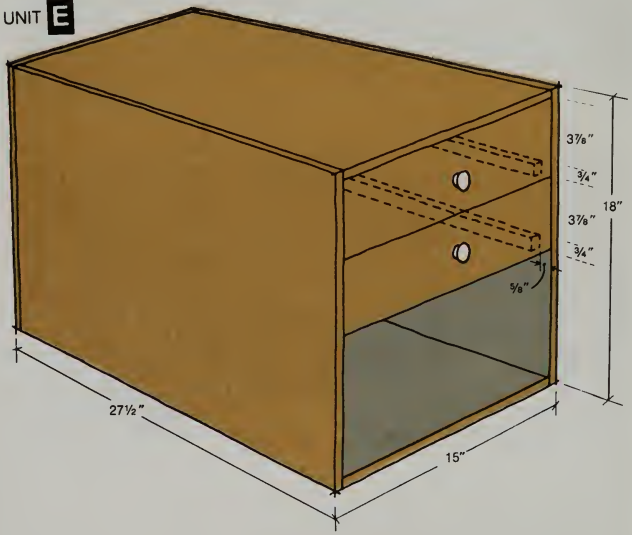
Rout or chisel ¼" x ¼" channels inside of drawer fronts to accept drawer bottoms. (Optional: Cut ¾" wide strips of ⅝" plywood to length. Nail them inside of drawer fronts for support of bottoms. Reduce length of drawer support runners by ⅝".)



Cut four strips ¾" wide by 26½" long from excess ⅝" plywood for drawer support runners.
Mark their locations on insides of E sides.
Glue and nail with brads.
Glue and nail box assembly together.

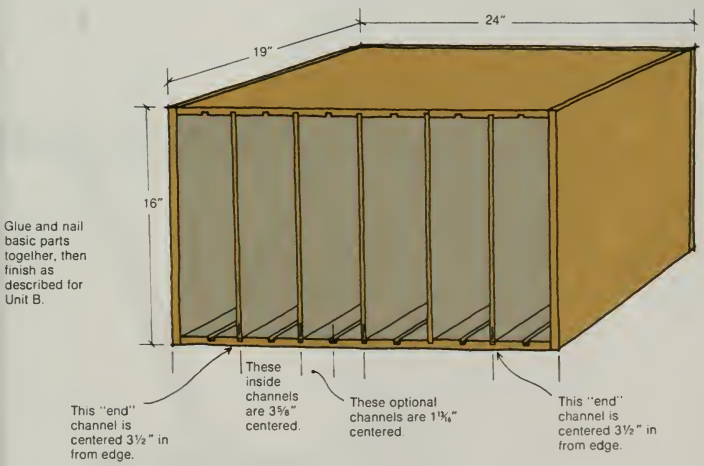
Drill holes for drawer pulls.
Nail and glue drawer assemblies, and finish as described for unit B.

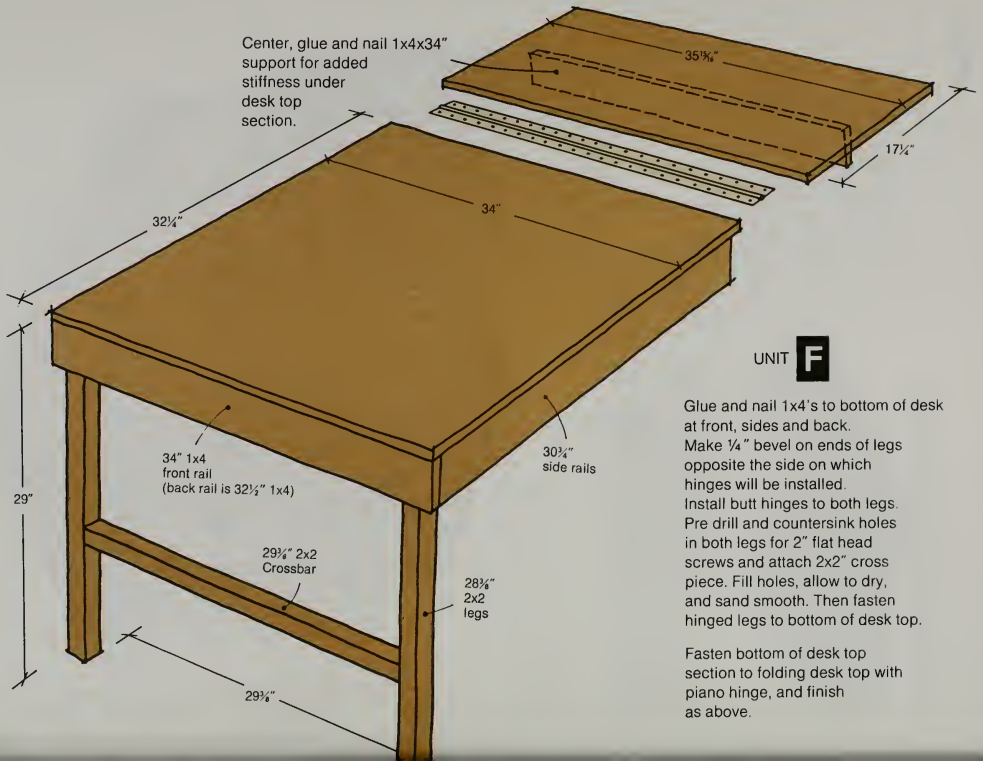
UNIT **E**



UNIT **A**

On top and bottom, rout or saw and chisel five ¼" x ¼" channels for dividers, spacing them as shown. (Note: six additional channels are shown as optional so dividers can be moved closer together or farther apart, or to accommodate up to six additional dividers.


24"
19"
16"
Glue and nail basic parts together, then finish as described for Unit B.
This "end" channel is centered 3½" in from edge.
These inside channels are 3⅝" centered.
These optional channels are 1¹³⁄₁₆" centered.
This "end" channel is centered 3½" in from edge.

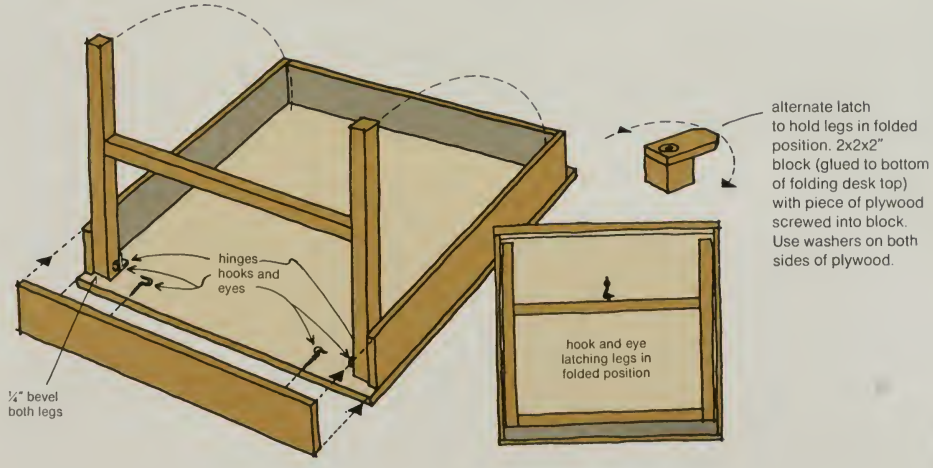


UNIT **F**

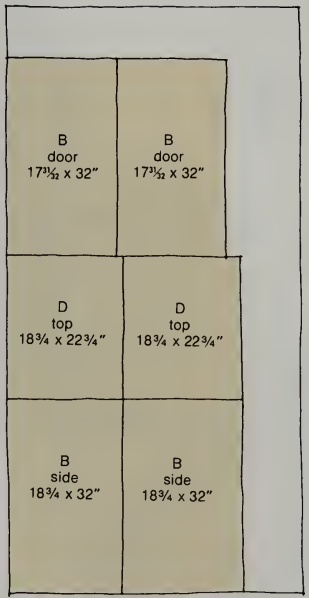
Glue and nail 1x4's to bottom of desk at front, sides and back.
Make ¼" bevel on ends of legs opposite the side on which hinges will be installed.
Install butt hinges to both legs.
Pre drill and countersink holes in both legs for 2" flat head screws and attach 2x2" cross piece. Fill holes, allow to dry, and sand smooth. Then fasten hinged legs to bottom of desk top.

Fasten bottom of desk top section to folding desk top with piano hinge, and finish as above.

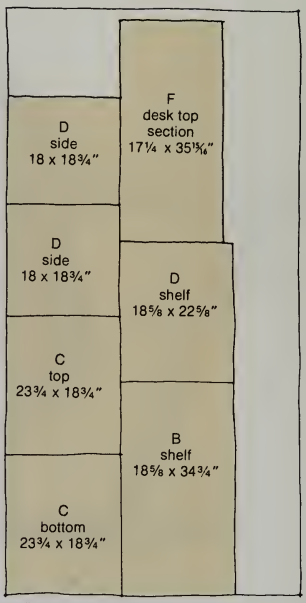
Attach screen door hook to inside of desk near each leg, and attach eye to each leg (to latch legs in open position). Also attach screen door hook and eye to cross piece of legs and bottom of desk (so legs can be latched in folded position).


alternate latch to hold legs in folded position. 2x2x2" block (glued to bottom of folding desk top) with piece of plywood screwed into block. Use washers on both sides of plywood.
hinges
hooks and eyes
¼" bevel both legs
hook and eye latching legs in folded position

2550 *Divider Unit Combines Desk and Storage Space*

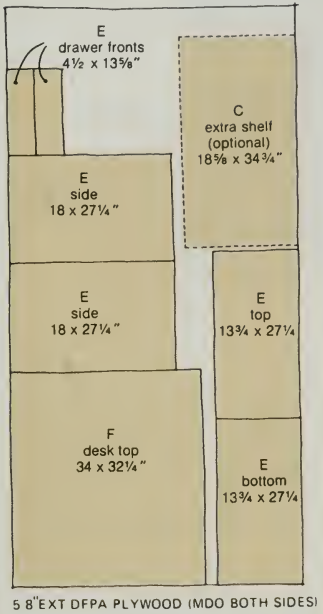


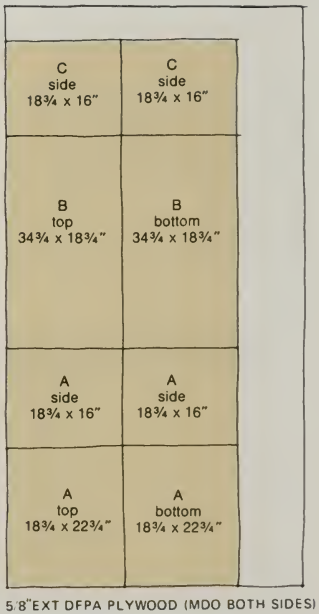
5/8" EXT-DFPA PLYWOOD (MDO BOTH SIDES)

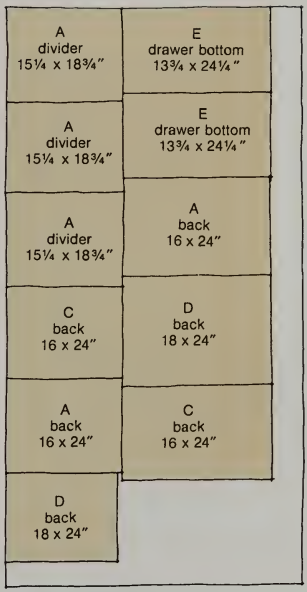


5/8" EXT-DFPA PLYWOOD (MDO BOTH SIDES)

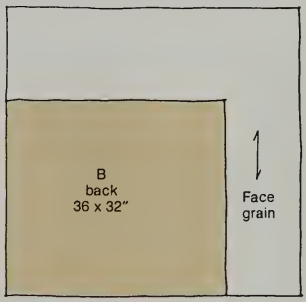
Divider Unit Combines Desk and Storage Space 2551







1/4"B-B INT-DFPA PLYWOOD



1/4"B-B INT-DFPA PLYWOOD

shop. When they are finished and painted, carry them to the place where you intend to erect the unit. Do the same thing with the framing.

When all the parts and assemblies are on site, erect the unit with screws as shown in the plans. Don't use glue at this stage. You may wish to move the unit some day. If it is merely screwed together, it can be broken down into easily handled parts and reassembled at its new location.

See also: CABINETS; DESKS; EARLY AMERICAN; FURNITURE, INDOOR; LUMBER; ROOM DIVIDERS; SHELVES; STORAGE WALL; WORKSHOP.

MATERIALS LIST

Quantity	Size and Description	Purpose
4	⅝" 4'x8' EXT-DFPA plywood (medium density overlay both sides)	cabinets, shelves, etc.
1½	¼" 4'x8' B-B INT-DFPA plywood	dividers, backs and drawer bottoms
1	2" 2"x72' select grade lumber	frame and desk legs
1	1" 4"x60' select grade lumber	frame and desk drawers
as needed	1¼" #8 oval head screws and finish washers	
as needed	2" #8 flat head screws	

NOTE: Also need cabinet door hinges, door pulls, magnetic door catches, brads, piano hinge, butt hinges, hooks and eyes (small), 6d finishing nails, surfacing putty, sandpaper, wood glue and finishing materials.

This carport-like boat storage shed is convenient to use, easy to build with simple tools.

Build a Storage Port for Your Boat

One wall of this boat storage shed is already standing—it's the wall of your house or garage —and the rest is easy to build with simple tools

PUTTING A ROOF OVER your boat is not as difficult as you might think. This carport type shelter is easy to build with simple tools, and once it is erected, you can just back your trailer into it with the boat on it and the boat is stored.

Before starting, check the plans and make certain you understand each construction step. Then, take your list of materials to your lumber dealer and place your order. Be sure to get the grade and type of each item specified.

When the materials are on hand, layout the foundation with string and stakes, making sure the outside wall is parallel to the wall of the house and that the ends are perpendicular to the house.

You can check whether the angles are square by measuring the diagonals from corner to corner. If the diagonals are equal, the layout is a precise rectangle.

Dig trenches for the foundation blocks, each 30 inches long, 24 inches wide and 6 inches deep, where frost is not a problem. In other areas, dig to the frost line, or as deep as local codes specify. Fill the excess depth with concrete, then set each foundation block on the concrete.

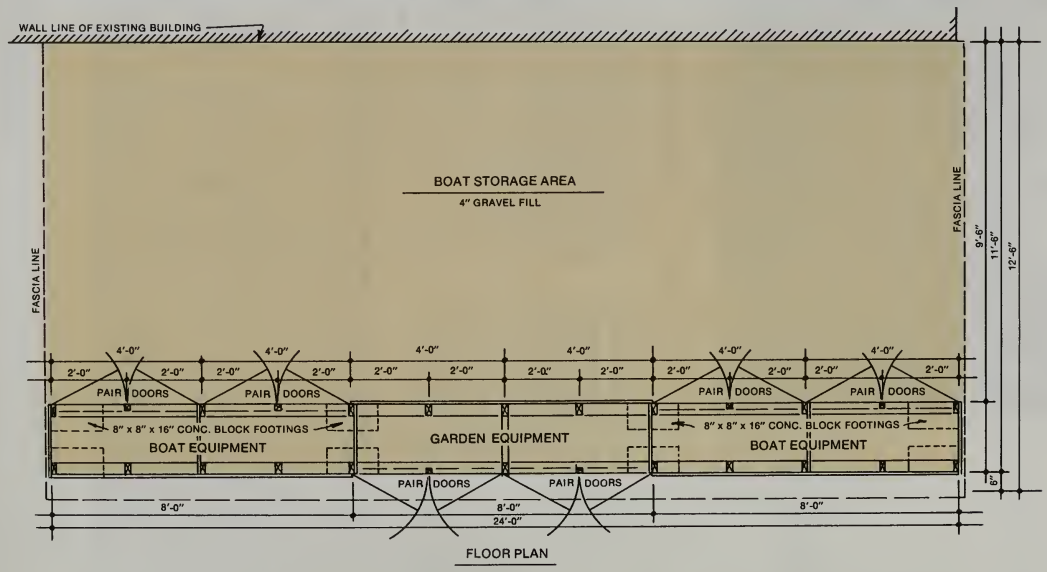
Each of the eight footing blocks is a 8 x 8 x 16-inch concrete or cinder block layed lengthwise in the same direction as the wall. Level each with a line level and fill the holes in the blocks with concrete. Imbed one anchor bolt in each end block and two anchor bolts in each of the four center blocks.

Leave the foundation blocks undisturbed for at least 24 hours to allow the concrete to set.

While the concrete is setting, select all material that is to be painted or stained and apply primer or first stain coat to all areas, including the edges of the plywood. Cut the lumber and plywood to shape, tapering the tops of the studs to allow for the slight slope of the roof.

Drill the bottom sill plate 2 x 4s to receive the bolts embedded in the footing blocks. For the bottom sill plate, buy treated lumber or treat it with a wood

storage, lumber: see lumber
storage shed: see fence-storage shed


WALL LINE OF EXISTING BUILDING
BOAT STORAGE AREA
4" GRAVEL FILL
FASCIA LINE
FASCIA LINE
9'-6"
11'-6"
12'-6"
4'-0"
2'-0"
PAIR DOORS
8" x 8" x 16" CONC. BLOCK FOOTINGS
BOAT EQUIPMENT
GARDEN EQUIPMENT
8'-0"
24'-0"

FLOOR PLAN

Build a Storage Port for Your Boat

preservative yourself. Place an 8 x 16-inch sheet of #30 builder's paper over each footing block and bolt the sill plate pieces down. Recess the nuts flush with the surface of the wood and hacksaw off the excess length of each bolt.

Nail down the second sill plate over the first with 16d galvanized nails spaced no more than 12 inches apart. Make sure the butt joints of the second sill plate do not fall over the those of the first. Nail the ¾-inch exterior plywood floor to the sill plates of the equipment storage areas.

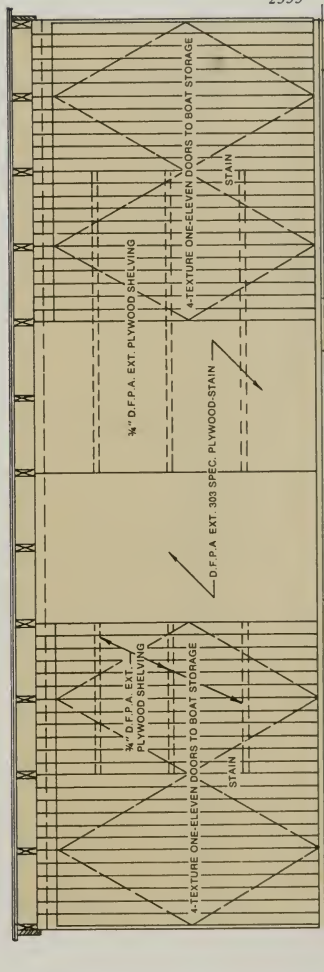
Attach the 2 x 4-inch ledger plate to the existing building with ½-inch round bolts on 2-foot centers.

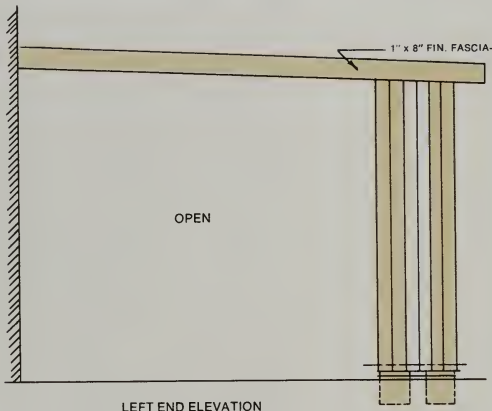
Lay the roof joists on the ground with the roof sheathing over them to form a working surface. On this surface, lay out the studs and base plate for the exterior wall. Nail the base plate to the studs with 16d common galvanized nails and apply the exterior plywood sheathing with 6d non-corrosive box or casing nails. Space the nails on 6-inch centers along all edges and on 12-inch centers on intermediate studs.

After the wall is erected, the rafters will be tied to the studs by gusset plates. The rafter is directly on top of the stud and a gusset plate—a 3⅝ x 12-inch strip of ⅜-inch plywood—is nailed wtih 6d nails to the rafter and to the stud on each side. Nail the gusset strips to each side of each stud while the wall is still flat on the platform.

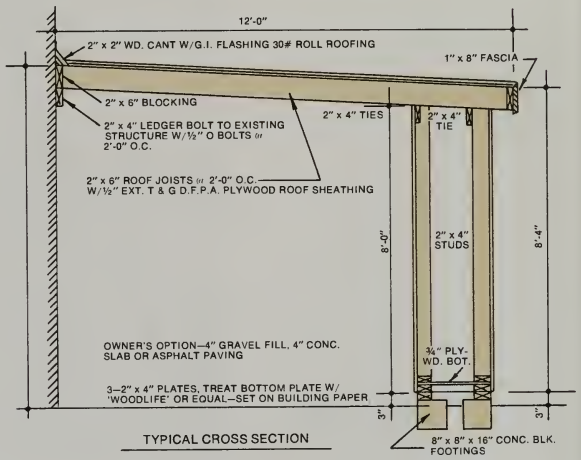
With a little help from your friends, tilt the wall upward into position on the outside edge of the plywood floor over the second and first sill plates beneath. Brace it in position with 2 x 4s and when you are certain it is square, nail the sill plate that is attached to the bottoms of the studs to the plywood floor with 16d common nails on 12-inch centers.

Run the 2 x 6-inch roof joists from the outside wall to the ledger plate on the wall of the building, toe nailing each to the building wall and the ledger plate. Use six

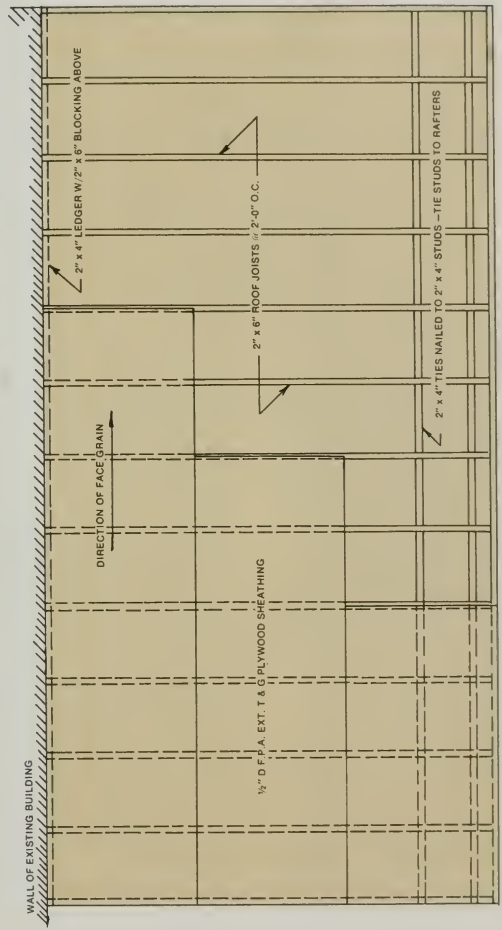




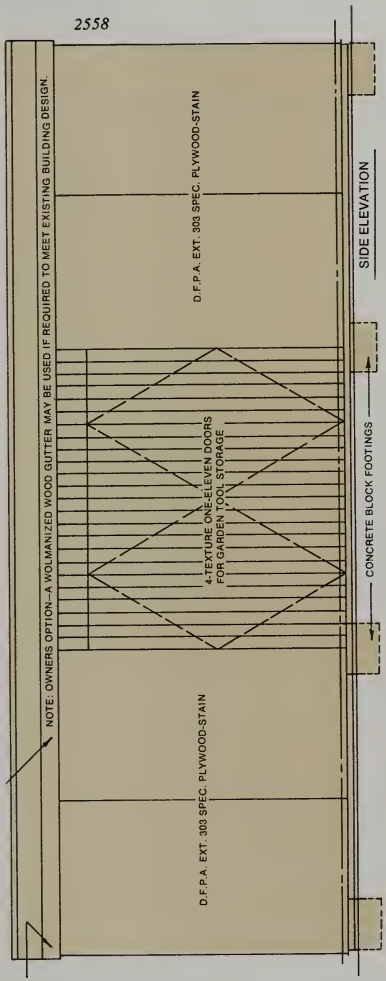
LEFT END ELEVATION
RIGHT END SIMILAR


12'-0"
2" x 2" WD. CANT W/G.I. FLASHING 30# ROLL ROOFING
1" x 8" FASCIA
2" x 6" BLOCKING
2" x 4" LEDGER BOLT TO EXISTING STRUCTURE W/½" O BOLTS @ 2'-0" O.C.
2" x 4" TIES
2" x 4" TIE
2" x 6" ROOF JOISTS @ 2'-0" O.C. W/½" EXT. T & G D.F.P.A. PLYWOOD ROOF SHEATHING
8'-0"
2" x 4" STUDS
8'-4"
OWNER'S OPTION—4" GRAVEL FILL, 4" CONC. SLAB OR ASPHALT PAVING
¾" PLY. WD. BOT.
3—2" x 4" PLATES, TREAT BOTTOM PLATE W/ 'WOODLIFE' OR EQUAL—SET ON BUILDING PAPER
3"
3"
8" x 8" x 16" CONC. BLK. FOOTINGS

TYPICAL CROSS SECTION


WALL OF EXISTING BUILDING
2" x 4" LEDGER W/2" x 6" BLOCKING ABOVE
2" x 6" ROOF JOISTS @ 2'-0" O.C.
2" x 4" TIES NAILED TO 2" x 4" STUDS – TIE STUDS TO RAFTERS
DIRECTION OF FACE GRAIN
½" D.F.P.A. EXT. T & G PLYWOOD SHEATHING

ROOF FRAMING PLAN


2558
NOTE: OWNERS OPTION—A WOLMANIZED WOOD GUTTER MAY BE USED IF REQUIRED TO MEET EXISTING BUILDING DESIGN.
D.F.P.A. EXT. 303 SPEC. PLYWOOD-STAIN
4-TEXTURE ONE-ELEVEN DOORS FOR GARDEN TOOL STORAGE
D.F.P.A. EXT. 303 SPEC. PLYWOOD-STAIN
SIDE ELEVATION
CONCRETE BLOCK FOOTINGS

Build a Storage Port for Your Boat

16d nails per joist. The joists should be on 2-foot centers. Nail the gusset plates to the joists at the outside wall with 6d nails. Nail 2 x 6 blocking between the joists over the ledger plate.

When all the roof joists are up, nail down the ½-inch plywood roof sheathing, staggering the butt joints as indicated on the plans. Use 6d nails spaced 6 inches apart at edges and 12 inches apart at intermediate joists. Next apply the 1 x 8-inch fascia and the 2 x 2-inch cant strip is indicated in the plans. Install 24-gauge galvanized iron flashing over the cant strip and lay down roll roofing according to the instructions of the roofing manufacturer.

Dig away 4 or 5 inches of the boat port floor and replace it with crushed gravel.

When you reach this stage, most of the work is done. All that remains is to construct the equipment cabinets and complete the painting and staining.

Start the equipment cabinets by nailing the 2 x 4 divider studs in place and nailing the ¼-inch plywood divider panels to the studs.

Nail the shelf supports to the divider walls. Then nail two ⅜-inch plywood panels to the inside wall studs in the same way as the outside panels were nailed. Position the 2 x 2 door stops and nail them in place. Cut and install plywood shelves.

Finally, cut doors of ⅝-inch exterior textured plywood panel. Cut them to fit and hang them with zinc-coated fast pin butts. Install suitable catches and hasps. Install 2 x 2 door stops and doors on the outside garden cabinet in the same way. The boat port is ready for painting. One final application of stain to the doors and siding should be sufficient. Give the painted portions—shelves, dividers, fascia, etc.—two final coats. Paint the underside of the roof panels and joists a lighter color than the rest of the boat port.

See also: ADDITIONS, HOME; CONCRETE; HOME IMPROVEMENT; LUMBER; WOODWORKING.

Getting Your Boat Ready for Storage

Use these tips to get a jump on the next boating season while your craft is out of the water, and if it is a small boat, use this method of storing it in your garage

A FEW FORTUNATE BOATMEN live in a warm climate where boating can be enjoyed every month of the year. The rest of us are faced with the annual chore of hauling and storing our craft for the winter. What we do at this time of year has an important bearing on what we will be able to do when spring rolls around.

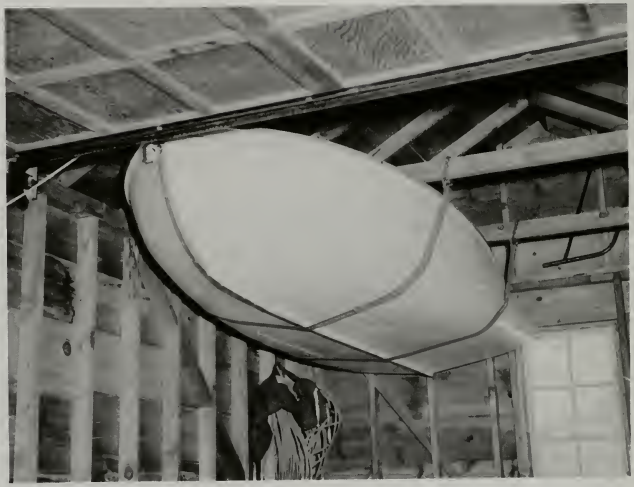
The most important thing is to provide proper support for the boat when it is hauled. A properly adjusted trailer gives excellent support. Be sure that the keel is supported evenly for its entire length, and that heavy areas of the boat, such as the engine compartment, are given adequate support. If an outboard engine is to be kept on the transom, be sure the keel at the transom is supported. Otherwise the weight of the motor will cause the boat to sag and give the hull a performance-robbing hook that's almost impossible to remove.

If the boat is to be stored on a cradle, the hull should be supported as above. Allow for placement of shims between supports and the hull, or supports and the ground, to adjust for variations in the ground level that result from alternate thawing and freezing. Whether on a cradle or trailer, the boat should rest with the bow high enough to allow any water that might reach the bilge to run out the transom drain. Be sure all limber holes are clear.

When your boat is hauled, clean it thoroughly. This includes topsides and interior as well as the bottom. Touch up any bare wood to protect it through the winter. If weather permits, or the boat is stored indoors, you can do major painting at this time. The new marine paints will not deteriorate during the winter. Of course, some bottom paints must be applied just prior to launching, and if the hull is an old carvel type you'll wait until spring to recaulk and then paint the hull.

Examine your boat carefully and make a list of all repairs and alterations you want done. You can schedule much of this work for the winter months, whether you do it yourself or have it done at your boatyard. You'll avoid a lot of last-minute confusion next spring.

Outboard engines should be removed from the boat, if at all feasible, and stored in a warm, dry place. Drain and flush out the cooling system with fresh water. Drain and replace the gear lubricant. Remove the



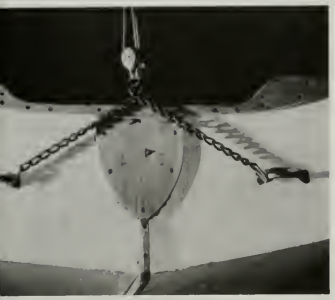
There is room overhead for a boat at least 12 feet long in the average one-car garage, despite the familiar clutter of garden tools and play equipment.

spark plugs (you'll want to install new ones at the start of the next season) and squirt preservative oil into each cylinder. Touch up any bare metal, and when the paint is dry give the whole works a light coat of preservative oil. Remove the propeller and put a good coat of grease on the shaft. Store the propeller separately; if damaged, send it to an authorized repair shop, or replace it if necessary.

Inboard engines, including those with freshwater cooling systems, should be drained and flushed. Drain the crankcase and refill with preservative oil, remove the plugs and pour preservative oil into each cylinder.

Whether you have an inboard or outboard, inspect all components of the ignition and fuel systems. Schedule any needed maintenance with your boatyard operator or authorized outboard repair man. He would rather do it as early as possible than wait for the spring rush.

Go over your boat and remove everything that can be carted home. This includes galley gear, cushions and linens, mattresses, bunk pads, electronic gear, and all lines and fenders. If possible, remove chromeplated deck hardware, navigation lights and trim. Also take out any wooden hatch covers, cabinet doors, and wood trim items that need refinishing and can be removed without a major operation. All these items will fare better in a warm, dry atmosphere, and they won't be where some stranger with sticky fingers and a screwdriver can get at them.



An arrangement like this at the boat's stern will prevent the boat from turning over while it is being hoisted.

Do you look forward to those long winter evenings when you can just sit around and relax? You're not going to have them. It's time to remove the old finish from all those bits of wood you brought home and repaint or varnish them as required. Scour all your galley gear, including the stove, and clean and mend your linens and seat cushions. Go over all your lines; discard those that are frayed or worn. You may need to whip a few raveled ends, too, or at least wrap a few turns of electricians tape around them.

Go over all your chrome-plated gear.

The chain loops over the rafter to hold the strap in position.

Use two short pieces of drilled strap iron at each end of the upholstery webbing support strap. Wrap the webbing around one piece, then bolt the two pieces together tightly. Use additional nuts to hold the chain on the fitting.

Sometimes a scouring pad will do much to restore a surface that looks bad, but if the chrome is badly pitted or worn so thin that the base metal shows through, replace the item or have it replated.

This is the time to have all your radio gear checked by a competent serviceman. The radiotelephone should be inspected by a licensed radio technician and reinstalled by him next spring. He can go over depth finders and radio direction finders too, and is well worth his fee.

When you've got everything off the boat, put a cover on it. Your cover should be peaked as high as possible to prevent accumulations of snow or pockets of water. Be sure to leave an opening at each end of the cover so that air can circulate freely. Trapped moisture, whether from condensation or rain, will lead to dry rot in wood. Adequate ventilation will dry out such moisture before any damage is done.

It's possible to seal up fiberglass boats and there is no reason why this isn't feasible if no exposed wood is present and nothing is left aboard that might corrode.

By careful inspection now and scheduling needed work for the cold months ahead, your spring fitting-out will be fast and simple. You'll be in the water while less foresighted boatmen are still trying to clean up this season's mess.

One convenient, space-saving way to stow a small boat ashore is to hang it overhead in your garage.

You can easily hang the hull up against the ceiling joists out of the way of your car, using two simple hoists made from inexpensive clothesline pulleys and clothesline. At your convenience during the off-season, it's short work to back off your car and lower the boat to do the cleaning and painting chores under roof. And, if you elect to do the job in installments, the car can reoccupy its normal place each night.

The typical one-car garage of 12 x 20 feet with an overhead-type door can accommodate a boat up to 12 feet long when suspended from the rafters behind the door in overhead position. If rafters are in good shape, they should support an average boat up to 16 feet long, in garages with hinged or sliding doors.

Make the hoisting tackle with single and double clothesline pulley blocks to give a 3-to-1 lifting advantage. Thread each set of blocks with four times as much line as the distance the boat is to be lifted.

Install ¼-inch screw hooks (of the type used to hold hammocks) into sides of rafters at points over desired storage location for the boat and separated by length of the boat. Each hook is strong enough to support 150 lbs. If your boat weighs that much or more, use the plate-type hook with four screw holes to retain a 100 per cent safety factor. Fasten awning cleats to nearby studs in the garage wall to make the lines fast after hoisting.

Position the boat on its trailer or the garage floor directly below the hooks. Attach double pulley blocks of each set of hoisting tackle to the rafter hooks. Attach the end of one hoist line and its single pulley with an S-hook to the bow ring or front eye bolt of the hull. Hook the other line in a similar manner to a chain saddle, which is fastened to or passed through lifting handles or cleats at the transom to prevent the boat from turning over when lifted.

Now hoist the boat up as far as it will go and make lines fast on side wall cleats. This will take little time, if you have a helper to handle one of the lines, and little effort owing to the 3-to-1 advantage of the tackle. If alone, alternate between lines, hoisting a little at a time.

Once the boat is in storage position, its weight should be transferred to safety chains to avert an accident if someone tampers with the lines. Use a stepladder so that you can measure the distance between rafter and boat connections. Cut two lengths of sturdy chain so that they are about 3 inches

longer than the measured distance, including lower hook. Attach chains to the rafter hooks and boat connections. Then lower boat a few inches until chains carry the load and refasten lines.

Old tire chains are adequate for this purpose, if cross links are in good condition. If not, obtain chain and ¼-inch S-hooks at a hardware store.

Intermediate support bands are needed since a boat may sag when only suspended from bow and stern. Dinghies and prams up to 10 feet long can get by with one such support; 12-foot boats will need two and larger craft three. After determining approximate length, prepare the bands from upholstered webbing or belting.

Position bands so that they are equally spaced along the hull. Fasten one end of each band to a screw hook and the other to a rope. Pass ropes over a ceiling joist or a hook located higher than boat position. Tighten ropes until each band just carries its share of the load, without taking the load off an adjoining support.

Your boat is now safely stored for the winter. Yet, five minutes' work brings it down, ten minutes puts it away.

See also: BOATING; MAINTENANCE, BOAT; OUTBOARD MOTORS.

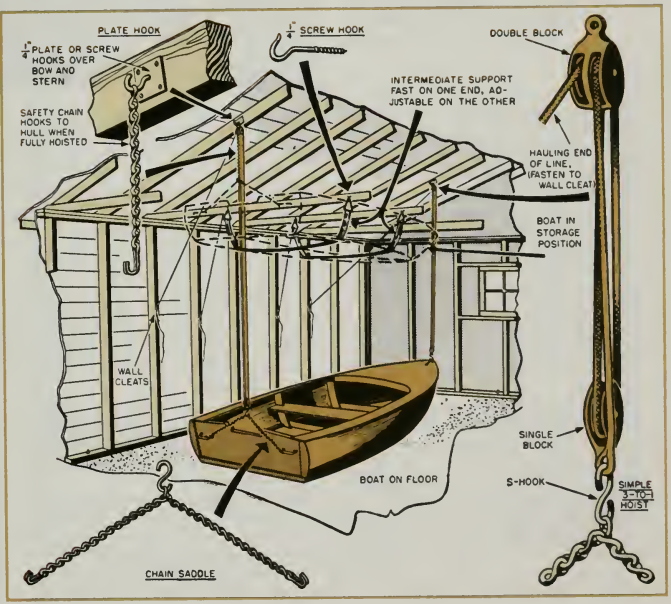


PLATE HOOK
¼" PLATE OR SCREW HOOKS OVER BOW AND STERN
SAFETY CHAIN HOOKS TO HULL WHEN FULLY HOISTED
¼" SCREW HOOK
INTERMEDIATE SUPPORT FAST ON ONE END, ADJUSTABLE ON THE OTHER
DOUBLE BLOCK
HAULING END OF LINE, (FASTEN TO WALL CLEAT)
BOAT IN STORAGE POSITION
WALL CLEATS
SINGLE BLOCK
BOAT ON FLOOR
S-HOOK
SIMPLE 3-TON HOIST
CHAIN SADDLE

Cabinet Holds Sports Gear

This exterior cabinet shell and storage door can be adapted to hold a variety of sporting goods ranging from fishing gear to tennis rackets

YOU CAN BUILD ONE of these sportsman's cabinets or a row of them for hunting, fishing, camping, tennis, golf and skiing gear. All are basically the same, although the interior arrangements vary, and you can adapt them to your own needs.

To build the hunting cabinet, first lay out the parts on three sheets of plywood as shown on the plans. True the edges with 1/0 sandpaper on a block and rabbet one end of each side panel for the top.

Assemble the cabinet on its back on the floor with resin glue and finishing nails. Use your square frequently to assure accurate work.

While the glue is setting, glue and nail the door framing strips and the door panel together, following clearance all around as indicated.

When the glue of the cabinet has set, build the interior shelves and drawers as shown on the plans. Use glue and finishing nails to join the parts to each other and to the cabinet.

Cutouts for the gun stock and barrel racks are made as shown in the plans. The surest way to establish the correct height for each (so the weapons will fit in the case) is by trial and error. With your guns in the cabinet, try them at various heights. When the correct height is reached, hold the rack in place and mark the position. When the position of each rack is marked, remove the guns and glue and nail the racks in place. Install a hinged bar and a lock on front of the upper rack.

Next, build the shelves and facings in the door. The facing should be flush with the framing strips. Note how quarter-round molding is used to strengthen the inside corners of the facing.

Smooth all joints and slightly round the corners with 3/0 sandpaper. Fill any nail holes and exposed plywood edge grain with wood filler, smooth the entire cabinet with 3/0 sandpaper.

Place the cabinet on its back and attach the door to the cabinet with four pin-hinges. The door may be hinged at either side. Install a suitable catch or lock.

Give the whole cabinet a coat of primer and then finish it with two coats of semi-

Cabinet Holds Sports Gear

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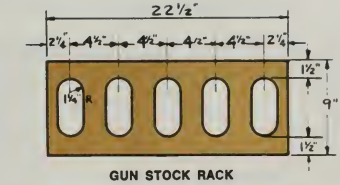
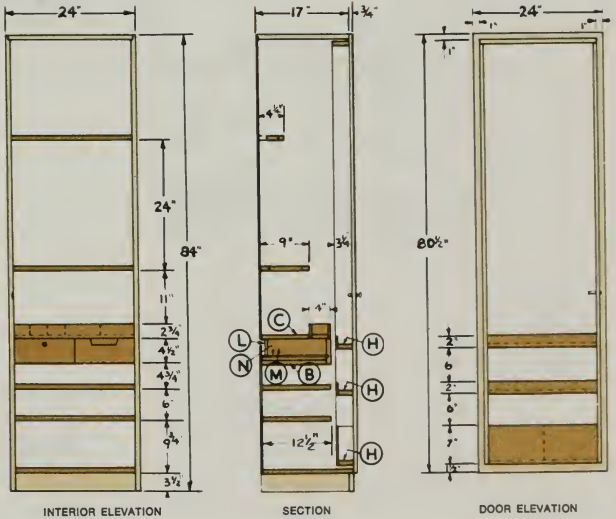
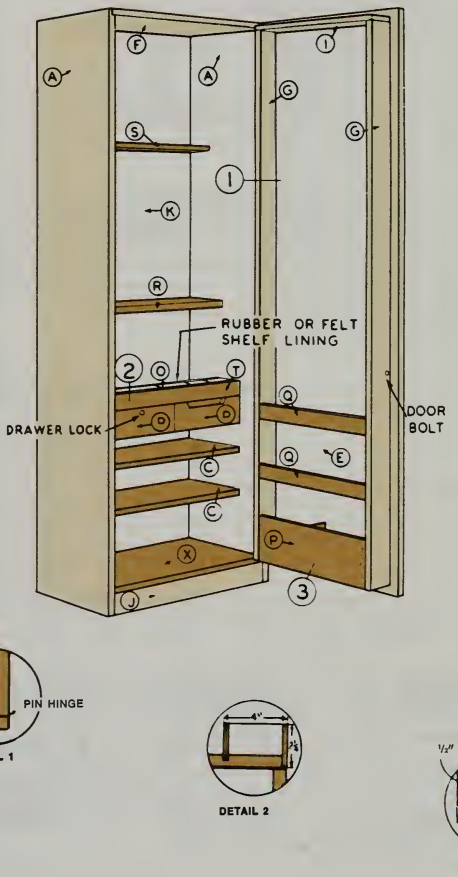


HUNTING AND FISHING CABINET



HUNTING AND FISHING CABINET. (cont.)



Cabinet Holds Sports Gear

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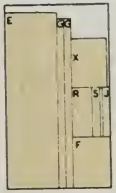
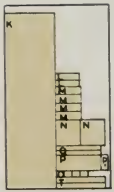


¾" x 4'-0" x 7'0"



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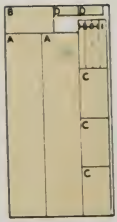


¾" x 4'-0" x 8'-0"

CUTTING DIAGRAMS

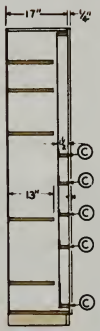
MATERIALS LIST—Hunting and Fishing Cabinet

Quantity	Size and Description	Purpose
2	¾" 17"x84" A-D interior plywood	sides
1	¾" 12"x22½" A-D interior plywood	drawer shelf
3	¾" 12½"x22½" A-D interior plywood	shelves
2	¾" 4½"x11¼" A-D interior plywood	drawer fronts
1	¾" 24"x80½" A-D interior plywood	door
1	¾" 17"x23¼" A-D interior plywood	top
2	¾" 3¼"x77¼" A-D interior plywood	door frame
3	¾" 3"x20½" A-D interior plywood	door shelves
1	¾" 3½"x22½" A-D interior plywood	base
1	¾" 3¼"x22" A-D interior plywood	door top shelf
1	¾" 9"x22½" A-D interior plywood	gun stock rack
1	¾" 4¼"x22½" A-D interior plywood	barrel rack
1	¾" 16¾"x22½" A-D interior plywood	bottom shelf
1	¼" 23¼"x80⅛" A-D interior plywood	back
2	¼" 3"x11" A-D interior plywood	drawer backs
4	¼" 3¾"x12⅛" A-D interior plywood	drawer sides
2	¼" 10¾"x12⅛" A-D interior plywood	drawer bottoms
4	¼" 2"x3½" A-D interior plywood	dividers
1	¼" 7"x20½" A-D interior plywood	door shelf fascia
1	¼" 3"x6¼" A-D interior plywood	door shelf divider
2	¼" 2"x20½" A-D interior plywood	door shelf fascia
1	¼" 2¾"x22½" A-D interior plywood	gun shelf face
1	¼" 2⅜"x22½" A-D interior plywood	gun shelf face
1	¼" 20½"x56" cork	backing
	9"x22½" rubber or felt	lining

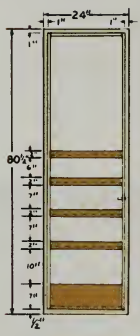
NOTE: Also need hinge and lock for barrel rack, drawer lock, door bolt, pin hinges, 4d and 6d finishing nails, glue, clips and finishing materials.

CAMP, HIKE AND CLIMB CABINET

INTERIOR ELEVATION

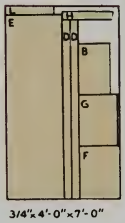


SECTION



DOOR ELEVATION

3.4"x 4'-0"x 8'-0"



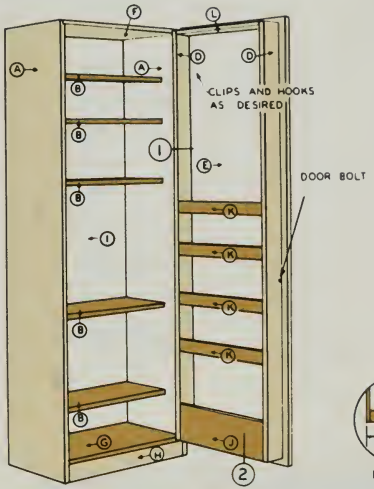
3/4"x 4'-0"x 7'-0"

1/4"x 2'-0"x 8'-0"

ALL PLYWOOD INTERIOR A-D

CUTTING DIAGRAMS

Cabinet Holds Sports Gear



DETAIL 1

DETAIL 2

MATERIALS LIST—Camping and Hiking Cabinet

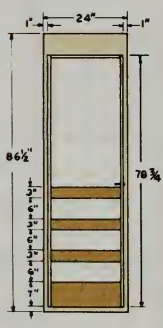
Quantity	Size and Description	Purpose
2	3/4" 17"x84" A-D interior plywood	sides
5	3/4" 13"x22 1/2" A-D interior plywood	shelves
5	3/4" 3"x20 1/2" A-D interior plywood	door shelves
2	3/4" 3 1/4"x78" A-D interior plywood	door side frame
1	3/4" 3 1/4"x20 1/2" A-D interior plywood	door top frame
1	3/4" 24"x80 1/2" A-D interior plywood	door
1	3/4" 17"x23 1/4" A-D interior plywood	top
1	3/4" 17"x22 1/2" A-D interior plywood	bottom shelf
1	3/4" 3 1/2"x22 1/2" A-D interior plywood	base
1	1/4" 23 1/4"x80 1/8" A-D interior plywood	back
1	1/4" 7"x20 1/2" A-D interior plywood	door shelf fascia
4	1/4" 2"x20 1/2" A-D interior plywood	door shelf fascia
1	1/4" 1/4"x30" quarter round molding	

NOTE: Also need pin hinges, door bolt, 4d and 6d finishing nails, glue, clips, hooks and finishing materials.

SKI, GOLF AND TENNIS CABINET

INTERIOR ELEVATION

SECTION



DOOR ELEVATION

MATERIALS LIST—Ski, Golf and Tennis Cabinet

Quantity	Size and Description	Purpose
2	¾" 17"x90" A-D interior plywood	sides
1	¾" 13"x85" A-D interior plywood	standard
1	¾" 24"x86½" A-D interior plywood	door
2	¾"x78¾" A-D interior plywood	door side frame
1	¾" 9"x13" A-D interior plywood	shelf
1	¾" 17"x23¼" A-D interior plywood	top
1	¾" 16¾"x22½" A-D interior plywood	bottom shelf
1	¾" 3½"x22½" A-D interior plywood	base
4	¾" 3"x20½" A-D interior plywood	door shelves
1	¾" 3¼"x20½" A-D interior plywood	top door tool shelf
1	¾" 2"x3" A-D interior plywood	drop bar catch
1	¾" ¾"x12¾" A-D interior plywood	drop bar
1	¼" 23¼"x86⅛" A-D interior plywood	back
1	¼" 7"x20½" A-D interior plywood	door shelf fascia
3	¼" 3"x20½" A-D interior plywood	door shelf fascia
1	½" ½"x30" quarter round molding	

NOTE: Also need hinge for drop bar, door bolt, pin hinges, 4d and 6d finishing nails, glue and finishing materials.

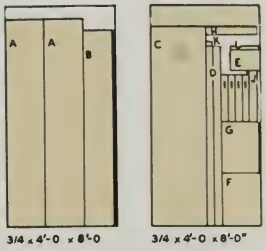
gloss enamel. Install any lining material you feel is appropriate and any fixtures or hardware needed to accommodate your gear.

The camping cabinet and the ski, golf and tennis cabinet are made in the same way as the hunting and fishing cabinet with different arrangements for the interior shelving as shown on the plans.

In addition, using the basic design for the cabinet shell and door, you can easily improvise your own interior design to accommodate almost anything.

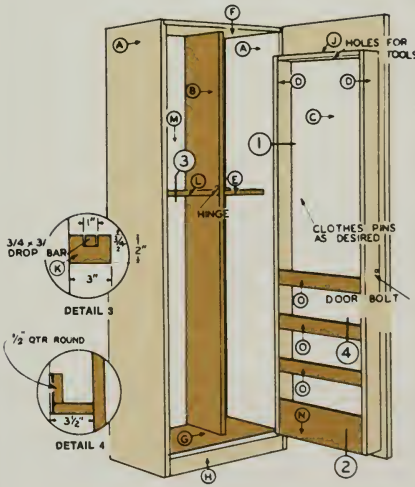
For indoor uses, such as in these cabinets, plywood can be joined with resin glue (white glue) and nails. Use 6d finishing nails for ¾ and ⅝-inch plywood, 3d or 4d nails for ⅜-inch and 1-inch brads for ¼-inch plywood.

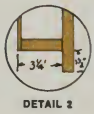
See also: DISPLAY CABINET; ROOM DIVIDERS; STORAGE; STORAGE WALL.



ALL PLYWOOD INTERIOR A-D

CUTTING DIAGRAMS





Wide countertop in front of window offers generous display area for family photographs, albums, special books or favorite magazines.

Decorative Storage Wall

Decorate and organize your study with this handsome built-in. If you don't have a study, create one by building this unit as a room divider

THE MYRIAD OF THINGS you want for paper work, reading or hobby will be kept handy, well displayed or hidden as you wish, by a storage wall in your study. By selecting wood to match the millwork, then shaping and finishing it to harmonize with your decorating style, your new built-in can rank with the finest furniture in the home.

If you have no study, you can create one economically by using the storage wall as a partial divider for a far corner of your

living or family room. The back can be enclosed with matching paneling or plywood, or left open so the unit can be used from either side. In the latter event, install doors on each side and double the depth of the bookcase.

You can make the unit in your workshop or build it in place, with necessary variations in details, type of wood and dimensions. Your choice of finish wood can be used throughout, but it will be more economical to use pine and plywood for the unexposed parts and cabinet interior members.

Building the cabinet. Determine the width first to decide how many partitions you'll need. Each partition space should have a pair of doors for easy access and should not be much wider than 3 feet so ¾-inch plywood shelves will support the storage load without bowing. When cabinet is 4 to 6 feet wide, plan for two partitioned spaces and four doors (12 to 18 inches wide); for a 6 to 10-foot cabinet, figure on three partitioned spaces and six doors.

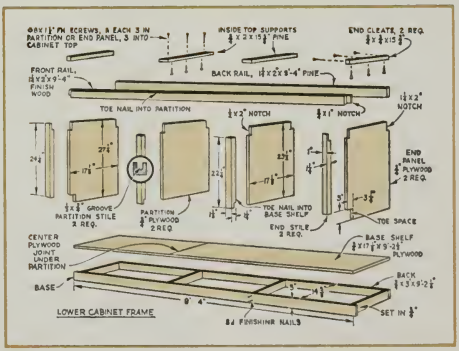
Before cutting any cabinet pieces, check and modify dimensions to suit your space. Build the base first, using 8*d* finishing nails in front and 8*d* box nails elsewhere. Note that finish wood is used only in front, also that the back piece is 1½ inches shorter than the front due to position of end panels.

You will probably need to piece the base shelf, if your cabinet is wider than 8 feet. Cut the ¾-inch plywood so the joint will be under a partition. Attach shelf to base with 6*d* box nails; where nailheads will not be concealed, use finishing nails.

Cut the end panels and partitions and notch top corners for the rails. Also notch end panel bottoms for the toe space. Cut and shape the stiles and front rail out of finish wood. Note that end stiles are 2 inches longer than partition stiles and rabbeted, while other stiles are grooved. Cut the back rail from pine, but do not notch.

Now glue front edges of end panels and partitions, then fit stiles over the plywood. To hold them in position until the glue sets, tack ¾-inch brads through sides of stiles.

Mark base shelf and top rails to position the partitions at equal distances. Fasten end panels to the outside crosspieces of the base and into edge of the base shelf, using 6*d* and 8*d* box nails. If an end is not to be


8 OR 10 FH SCREWS, 3 EACH 3 IN PARTITION OR END PANEL, 3 INTO CABINET TOP
INSIDE TOP SUPPORTS ¾ X 2 X 15½" PINE
END CLEATS, 2 REQ. ¾ X ¾ X 15"
FRONT RAIL, 1½ X 2 X 9'-4" FINISH WOOD
BACK RAIL, 1½ X 2 X 9'-4" PINE
TOE NAIL INTO PARTITION
¾ X 2" NOTCH
¾ X 1" NOTCH
1½ X 2" NOTCH
24"
27½"
17⅞"
22½"
¾ X 3" GROOVE PARTITION STILE 2 REQ.
PARTITION ¾ PLYWOOD 2 REQ.
TOE NAIL INTO BASE SHELF
END STILE 2 REQ.
END PANEL ¾ PLYWOOD 2 REQ.
TOE SPACE
CENTER PLYWOOD JOINT UNDER PARTITION
BASE SHELF ¾ X 17 X 9'-2½" PLYWOOD
BACK ¾ X 3 X 9'-2½"
BASE
LOWER CABINET FRAME
9'-4"
SET IN ¾"
8d FINISHING NAILS

concealed by a wall, use finishing nails. Prop the partitions in place, glue the top notches and set rails in place in the notches. Nail from back of the front rail into end stiles, using 1-inch brads. Toenail from top of rail into partitions. Attach stiles to base shelf by toe nailing from the bottom or sides.

If you plan to butt cabinet against a wall, particularly one with a decorative finish, no back is necessary. However, if you want it, cut it from ¼-inch plywood and install using *4d* box nails spaced 6 inches apart. If back will be seen, spread glue on the plywood and partition edges and tack back in place until glue sets.

Where the cabinet ends will show, the front piece of the base and top rail ends should be covered. Make the end stiles ¼-inch wider and add this width to their rabbets. Then cut ¼-inch finished plywood panel the same size as the end panel but eliminate the top notch and reduce the toe space notch from 3¼ inches to 2½ inches deep. This can be glued and tacked to the existing end panel. Now cut the top supports and end cleats of pine. Fasten cleats to inside top of the end panels and the supports to top of partitions with #8 x 1¼-inch flat head screws.

Make the top out of full-length boards of the finish wood. Lay them out on your worktable to the width of the top, glue all inside edges and butt-join them. Hold boards in place with pressure clamps every 2 feet. Slightly bevel top front edge of the cabinet top with a hand plane. After glue has dried, remove clamps. Position top on cabinet frame and fasten from underneath with three #8 x 1¼-inch flat head wood screws to each top support.

Attach the 2-foot shelf standards to ends and partitions. Cut the plywood shelves ½-inch less than depth and width of cabinet openings to permit adjustments on the shelf clips furnished with the standards.

Custom cabinet doors. Doors were designed to match the room's semi-rustic appearance and traditional furniture. Cut rails and stiles to dimensions modified to fit the height and half the width of a cabinet opening. Cut framing ends for ¼-inch mortise and tenons, using a dado blade. With the same blade cut a ¼-inch groove ½-inch deep on the inside edges of stiles and rails to within an inch of the ends.

To make the raised door panels, glue up three or four boards of the finish wood for each door and clamp until dry. Then trim height and width so each will be ⅛-inch shorter than that of grooved space in the frames. Panels can then float free regardless of contraction or expansion of the wood.

You can raise the front of the door panels with a molding head cutter attached to your bench saw. To raise panel backs, lip them with the bench saw blade. Variations in the design can be obtained according to the types of shaper heads you use.

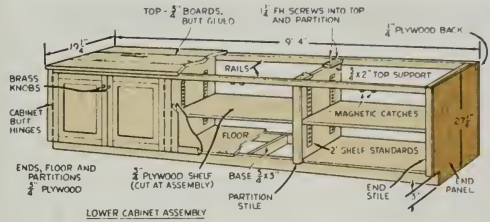
To assemble doors, slip stiles over a center panel. Glue the tenons and clamp rails in position on panel and stiles. Mortise door stiles and cabinet stiles for butt hinges and install doors on cabinet using #8 x 1-inch flat head screws. Attach knobs and install door catches.

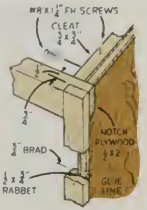
Bookcase. Build the bookcase to rest on the cabinet. The open case was designed to stand as high as the window frame and occupy all wall space between window and side wall.

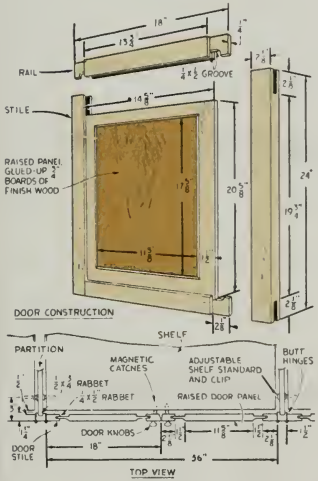
Cut all pieces from ¾ x 9½-inch boards of the finish wood after modifying dimensions, except the outside vertical member, which will stand against the adjoining wall. Note that end panels are doubled with spacer blocks separating the pieces just enough to be faced with molding revealing ¼-inch of panel on each side.

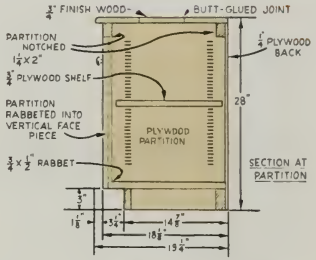
Make outside boards of the end panels 2½ inches longer than inside boards and cut dadoes in them to let in the top board. Cut similar dadoes in the top board to let

Decorative Storage Wall 2575









in the inside boards of the end panels and the partition. The vertical against the wall can be pine since it won't be seen. Or you may wish to eliminate this by substituting the 3-strip optional installation.

Before installing inside boards of the end panels, dado ¼-inch deep grooves in them to recess the shelf standards. Cut similar grooves on both sides of the partition. Grooves should extend about 46 inches from the top of panels and partitions, so that they will hold 48-inch shelf standards cut to 44-inch lengths and leave enough room to finish off the groove smoothly with filler blocks. Cut blocks from scrap of your finish wood, bevel bottom edges to clear rounded kerfs and glue them into the groove ends.

Slide top board in the end panel dadoes, then position entire case over the cabinet top. Secure it by toe nailing along panel edges into cabinet top and wall paneling. Toe nail through end panel edges which will later be covered by molding into the wall paneling and cabinet top, using 6*d* and 8*d* finishing nails. Also toe nail through front edge of partition.

When top board is in place, install a simi-

MATERIALS LIST—Lower Cabinet

Quantity	Size and Description	Purpose
7	3/4" 7 1/2"x10' finish wood	top, base frame front, door frames and raised door panels
1	1 1/4" 2 5/8"x10' finish wood	front rail
1	1 1/4" 1 5/8"x8' finish wood	stiles
1	3/4" 7 1/2"x10' pine	base framing, top supports and end cleats
1	1 1/4" 2 5/8"x10' pine	back rail
1 3/4	3/4" 4'x8' plywood	panels, partitions, base shelf and shelves
as needed	1 1/4" #8 flat head screws	
as needed	1" #8 flat head screws	

NOTE: Also need metal shelf standards, shelf support clips, butt hinges, magnetic door catches, 3/4" and 1" brad, 6d and 8d finishing nails, 4d, 6d and 8d box nails, glue and brass knobs.

MATERIALS LIST—Bookcase

Quantity	Size and Description	Purpose
6	3/4" 9 1/2"x7' finish wood	top, vertical members and shelves
1	3/4" 9 1/2"x5' pine	right side vertical (hidden against wall)
1	3/4" 2 5/8"x53" finish wood	framing over top
1	3/4" 2 5/8"x53" pine	framing over top
1	1/2" 1"x54" finish wood	face strip

NOTE: Also need metal shelf standards, shelf support clips, 8d box nails, 8d finishing nails, glue and finishing materials.

MATERIALS LIST—Lighting Valence

Quantity	Size and Description	Purpose
3	3/4" 7 1/2"x10' finish wood	butt-jointed base and fascia board
1	3/4" 2 5/8"x9' pine	backer boards
2	3/8" 1"x48" metal strap	brackets valance support
as needed	1 3/4" #12 flat head screws	

NOTE: Also need 4d and 8d box nails, wiring and electrical fixtures, and wood finishing materials.

lar length of ¾ x 2-inch framing directly over the front edge, spaced by 1½-inch blocks. This will provide a nailer for the top molding. Fasten another length of this framing on end to back of cover and against the wall. Install molding around case, using

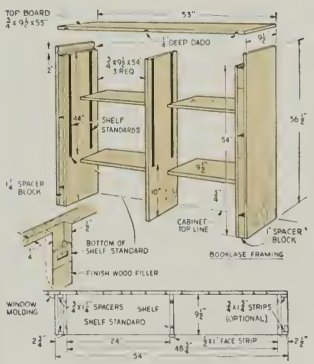
6*d* nails. Also nail a 1-inch face strip on front edge of partition.

Valance. The lighting valance rests over the bookcase and window frame, and is also supported by four iron straps. Your local blacksmith or metalworking shop can shape the straps for you.

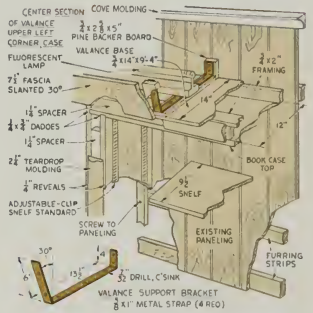
Since part of the valance base over the window will be exposed, it will be best to make it by joining two wide boards of your finish wood. Position base over cabinet and window framing, and attach with 6*d* or 8*d* box nails. For more support on the open end, you can install a wall cleat made of the same molding used for the bookcase and window.

Attach back and bottom of straps with #12 flat head screws to backer boards securely fastened to wall paneling and valance base. Complete the job by attaching slanted fronts of brackets to backer board and fascia board with #12 x 1¾-inch flat head screws. The valance is now ready for wiring and installation of fixtures for two 4-foot fluorescent light tubes.

Before finishing, go over the entire storage wall to set all exposed nails and brads.



STORAGE WALL (FRONT)



Fill holes with wood filler tinted to match color of the wood and sand smooth. Now you can apply a wiping stain, if desired, then follow with two or three coats of a quick-drying clear lacquer. Sand lightly and dust well between coats. Use fine (00) steel wool after final application and rub in a paste wax.

You can install a matching valance on the opposite end of the room, using the metal brackets as sole support and longer screws to secure them directly to the wall studs.

See also: CABINETS; FINISHING, WOOD; FURNITURE, INDOOR; ROOM DIVIDERS; STORAGE; WOODWORKING.

How to Make a Free-standing Storage Wall

The pre-cut dadoes of textured plywood serve as grooves for the slide-in, slide-out shelves and modules of the capacious wall unit

THIS ROOMY, FREE-STANDING storage unit uses the grooves already cut in textured plywood to provide channels for the slide-in, slide-out desk, bar cabinet and shelf modules that you can adjust at will as your storage needs change.

The unit is not difficult to build, but some power tools are required. A power saw is a must and a portable router would make the job easier.

Start by studying the drawings, the cutting diagrams and the Materials List until you are satisfied that you understand how each part is cut, what kind of material it is cut from and where it fits in the unit.

Cut the parts according to the plans. Assemble the vertical standards, shelves, desk, bar and cabinet units in your workshop. Then take them to the room where you plan to install the storage unit and assemble it on the site.

Glue and nail the end panels and the textured plywood to the 2 x 2-inch standards, leaving ½-inch showing along the edge of each standard. When you have done this, you will have four panels with textured plywood on both sides and two panels with textured plywood on one side and an end panel on the other.

Next, sand the mating edges of all components of the desk, bar and storage units. The tops and bottoms of the desk, bar and storage unit as well as the shelves and all other slide-in pieces must be rabbeted to a depth of $^{11}/_{16}$ inches to fit into the grooves cut in the textured plywood.

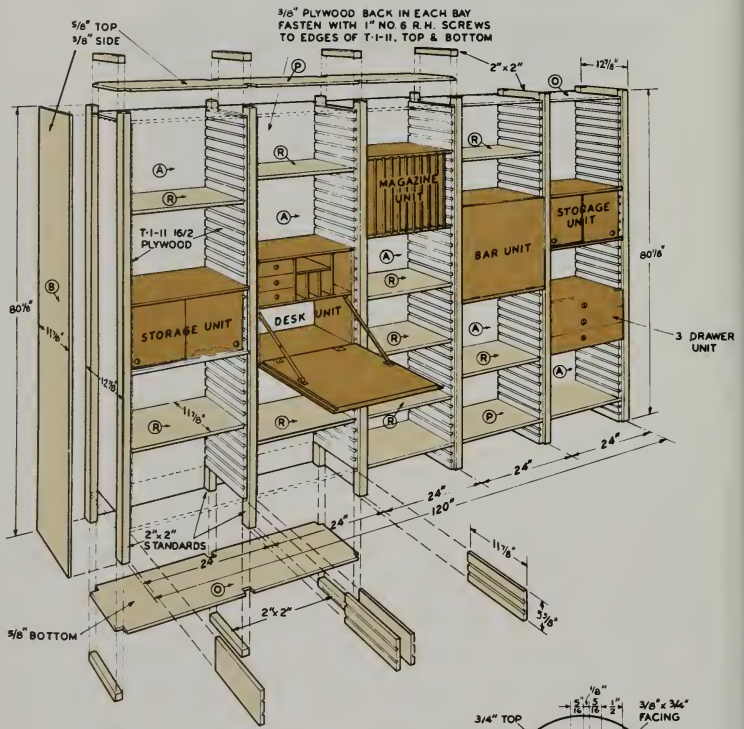
Assemble these units with nails and glue and appropriate hardware, as shown on the plans. The side of the doors of the desk and bar unit must be rabbeted as shown to a depth of 1⅛ inches to clear the lip of the opening.

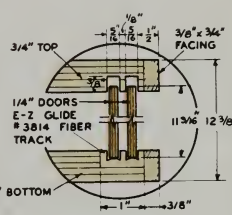
Glue and nail ¾ x ⅜-inch facing on the bottom front edges of the bar and desk unit and assemble each unit with the drawer slide and partitions in place in the desk.

MATERIALS LIST

Quantity	Size and Description	Purpose
5	¾" 22⅜"x78½" A-A interior plywood	back panels
2	¾" 11⅞"x80⅛" A-A interior plywood	side panels
10	¾" 11⅞"x15⅝" A-A interior plywood	magazine unit partitions
2	¾" 11½"x21¼" A-D interior plywood	bar and desk shelf
4	¾" 11⅞"x19⅝" A-D interior plywood	bar and desk sides
2	¾" 6"x11½" A-D interior plywood	desk partitions
3	¾" 2¾"x73⅜" A-D interior plywood	desk drawer backs
8	¾" 2¾"x11¼" A-D interior plywood	desk drawer sides
6	¾" 3⅝"x11⅞" A-D interior plywood	drawer unit sides
3	¾" 3⅜"x20¼" A-D interior plywood	drawer unit backs
3	¾" 11⅞"x21⅝" A-D interior plywood	drawer unit bottoms
1	¾" 3½"x11½" A-D interior plywood	desk shelf
3	¾" 3"x9" A-D interior plywood	desk drawer fronts
1	¾" 9"x11½" A-D interior plywood	desk partition
2	⅝" 11⅞x48 13/16" A-D interior plywood	top and bottom shelves
2	⅝" 11⅞"x72 13/16" A-D interior plywood	top and bottom shelves
12	⅝" 11⅞"x21⅝" A-D interior plywood	adjustable shelves, top and bottom magazine units
2	⅝" 11½"x21⅝" A-D interior plywood	bar top and desk top
6	¼" 11⅞"x21⅜" A-D interior plywood	bar bottom, desk bottom, storage unit top and bottom
2	¼" 4"x22⅜" A-D interior plywood	drawer unit front
1	¼" 4⅜"x22⅜" A-D interior plywood	top drawer unit front
2	¼" 19⅝"x22⅜" A-D interior plywood	bar door and desk unit door
4	¼" 10⅞"x11 3/16" A-D interior plywood	sliding doors
3	¼" 9"x11¼" A-D interior plywood	desk drawer bottoms
7	T-1-11 16/2 8' plywood panels	grooved sides
12	2" 2"x8' lumber of your choice	standards
1	⅜" ½"x8' lumber of your choice	drawer guides
1	⅜" ¾"x12' lumber of your choice	edge facing
2	⅜" 1"x4' fiber track	
as needed	1" #6 round head screws	
as needed	1¼" #6 round head screws	

NOTE: Also need magnetic catches, cabinet hinges, metal lid supports, 4d finishing nails, glue and finishing materials.





SLIDING DOOR DETAIL

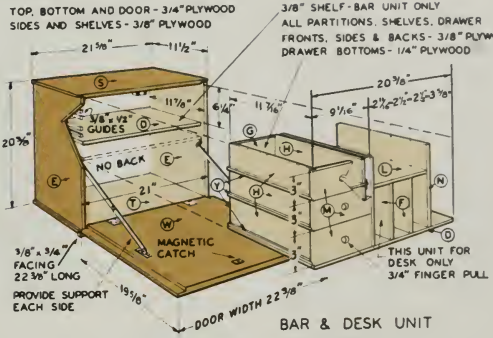
NOTE:

TOP & BOTTOM FIXED SHELVES ARE GLUED AND NAILED BETWEEN 2"x2" STANDARDS AS SHOWN.

ALL ADJUSTABLE SHELVES ARE CUT FROM 5/8" PLYWOOD AND SIDES RABBETED TO FIT 3/8"x 1/4" GROOVES OF T-1-11 16/2 PLYWOOD.

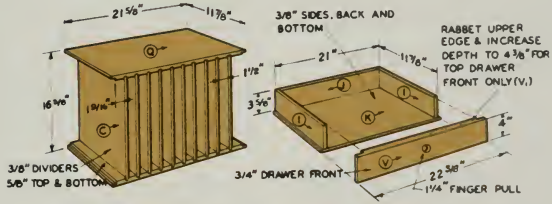
PLACE DESK UNIT SO DOOR WILL BE ABOUT 30" ABOVE FLOOR WHEN OPEN. DOOR OF BAR UNIT WHEN OPEN SHOULD BE APPROXIMATELY 36" ABOVE FLOOR.

PLACE OTHER UNITS AND SHELVES AS DESIRED.



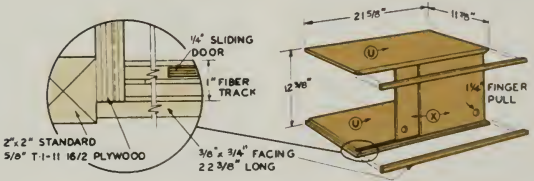
BAR & DESK UNIT

MAKE ONE OF EACH



MAGAZINE UNIT · MAKE ONE

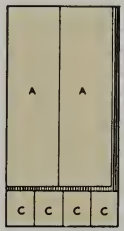
DRAWER UNIT · MAKE THREE



JAMB DETAIL · SLIDING DOOR

STORAGE UNIT · MAKE TWO

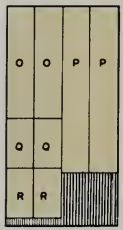
CUTTING DIAGRAMS



3/8" x 4'-0" x 8'-0" (2 REQ'D)
INTERIOR • DFPA • A-A

3/8" x 4'-0" x 8'-0"
INTERIOR • DFPA • A-A

3/8" x 4'-0" x 7'-0"
INTERIOR • DFPA • A-D



5/8" x 4'-0" x 8'-0"
INTERIOR • DFPA • A-D

Dado and rabbet the desk drawer fronts, drill ¾-inch holes as finger pulls and assemble the desk drawers, as shown in the plans.

Dado and rabbet the top and bottom pieces for the magazine unit. Assemble it with nails and glue.

The drawer storage unit plan shows three drawers, but you can make more if you wish. Make all the units the same except for the top one. The bottom of each drawer simply slides in and out of the grooves in the uprights.

Make the front of the top drawer 4⅜ inches high, rather than 4 inches high, so it will cover the front edge of the shelf that serves as the top of the drawer unit.

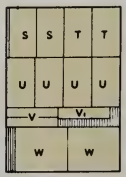
The sides of each drawer front are rabbeted 1⅛-inch and the bottom ⅜-inch. The top edge of the top drawer front only is also rabbeted. Drill 1¼-inch holes in the drawer fronts for finger pulls and assemble the drawers.

Rabbet the edges of the tops and bottoms of the sliding door storage units and nail ¾ x ⅜-inch facing to the front edges. Cut the dadoes for the sliding doors as shown and install the fiber track. Cut finger holes in the sliding door panels.

Now, bring all the parts and assemblies

5/8" x 4'-0" x 4'-0"
INTERIOR • DFPA • A-D

1/4" x 2'-0" x 4'-0"
DFPA • A-D



3/8" x 4'-0" x 6'-0"
INTERIOR • DFPA • A-D

to the site where you plan to erect the storage units.

Use glue and nails to fasten the bays together with the upper and lower shelf pieces and glue and nail the upper and lower crosspieces in place. Also attach the bottom sections of textured plywood to the uprights with glue and nails.

Attach the back panels to the edges of the textured plywood with 1-inch #6 round head screws. Fill all nail holes and flaws with wood paste, sand the unit and finish it with one coat of primer and two coats of enamel.

See also: FURNITURE, INDOOR; ROOM DIVIDER; STORAGE.

How to Install Acrylic Safety Glazing

Use this strong, clear, shatter-proof material where children play or in other danger spots, such as patio or storm doors

THE WINDOW THAT lets light into your home or the glass door that gives you a view of patio or lawn can also be a nearly invisible menace waiting for the unwary adult or running child to smash into it.

One way to reduce the hazard of broken windows—not to mention the expense and trouble—is to replace the glass in high-risk areas with clear acrylic glazing materials.

If you bump into an acrylic window you might get a bruise, but there will be no sharp, jagged shards to send you to a hospital emergency room.

Acrylic sheeting resists impact better than glass, and, when it is struck hard enough to shatter, it breaks into large dull-shaped pieces that rarely cause injury.

The safety features of acrylic sheet make it a suitable material for danger areas—children's rooms and playrooms, storm doors, patio doors and full-length windows —wherever there is a strong chance that someone might have an accident.

Working with acrylic sheeting is easy. With two exceptions, you can install a sheet of acrylic in the same way you would a pane of glass.

The first exception is in measuring the material. Acrylic expands and contracts more than glass, so it must be fitted somewhat more loosely. To do this, measure each dimension of the opening exactly. Then subtract $\frac{1}{32}$ of an inch for each foot for each dimension. This factor gives the acrylic room to expand. For example, if an opening is two feet wide and four feet high, subtract $\frac{2}{32}$ of an inch from the width and $\frac{4}{32}$ of an inch from the height. The result will give you the dimensions of the panel required to fill the space.

The second exception is cutting. Glass can be cut only with a glass cutter, and it can be a tricky operation for a beginner. Acrylic sheeting can be cut with ordinary power tools or with an inexpensive cutter that is available from the same hardware stores and building supply houses that sell the glazing material.

To replace a broken pane of glass in a storm door with an acrylic panel, first take out the drop-in sash frame and remove the broken glass carefully. Then, take out the rubber gasket and clean it. If it is in good shape, put it aside for re-use. If it is cracked or torn, throw it away and buy a new one.

Measure the opening in the drop-in sash exactly. Then subtract the expansion factor—$\frac{1}{32}$ of an inch for each foot in each dimension.

The next step is to order the acrylic sheet—Plexiglas is one type. For a drop-in sash or other applications that require a thin sheet, use material 0.08- or 0.10-inch thick, and be sure it has a label inscribed in the material itself. The label identifies the material as acrylic safety glazing and gives the brand name, manufacturer's name and U.S code number.

storm windows: see aluminum
stovepipe camera: see macrophotography
strato-cannon: see science projects
strippers: see solvents and strippers

To replace a glass storm door pane, first remove the drop-in sash frame, carefully clean out all the glass and remove the rubber gasket. Measure the opening exactly and substract an expansion factor of 1/32-inch for each foot in each dimension.

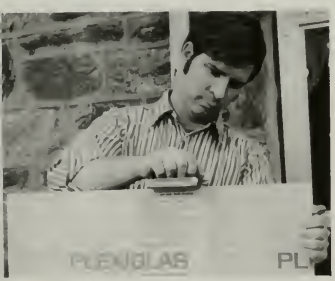
Acrylic glazing material can be cut with power tools or an inexpensive cutter. With the protective masking paper in place, score thin material five or six times with the cutter; thick material eight or 10 times.

After the edges of the acrylic panel have been smoothed with medium grit sandpaper and you are sure of the fit, peel off the masking paper that covers each side.

Place the material scored side up over a 3/4-inch dowel. Hold the long end on the surface and press the short end down. If the score is over the dowel, the material will snap apart easily along the score.

Use a putty knife to force the rubber gasket back into the channel of the drop-in sash frame.

For a stronger window, discard the drop-in frame and measure the door opening for a panel of $\frac{3}{16}$- or $\frac{1}{4}$-inch thick acrylic. Figure the expansion factor the same way as for a drop-in frame—$\frac{1}{32}$-inch per foot.



Once the panel is cut, smooth the edges with medium grit sandpaper.

Remove the protective paper and insert the panel directly in the door opening.

Some dealers will cut the material to exact dimensions for you, but you can cut it yourself with little difficulty.

Acrylic sheeting of the type ordinarily used for windows comes with protective masking paper covering each side. Leave this paper on while cutting, sanding or performing any similar operations.

To saw it, use a straightedge to mark a line on the masking paper, then cut along the line with a circular saw or powered jig saw, using the same kind of blade that is used for fine finish cuts in plywood or veneer.

Or, you can purchase a special cutter where you buy the acrylic sheet. To use this, simply score the material deeply with the cutter. Again, the masking paper should be in place. Score thin sheet with five or six passes of the blade. Use seven to 10 passes for 3/16- or 1/4-inch thick material. Lay the sheet over a 3/4-inch wooden dowel with the score on top of the sheet and directly over the length of the dowel. Press each side down and the acrylic will snap along the score.

After the cut is made, smooth the edges with medium grit sandpaper and round the corners and edges slightly. Leave the masking paper on while you sand.

Check to make sure the panel fits the opening. Remove the masking paper and slide the acrylic panel into the sash. Use your fingers or a putty knife to force the rubber gasket into the channel. Soaking the gasket in warm soapy water will make it easier to install.

You also can eliminate the drop-in sash and install an acrylic panel 3/16- or 1/4-inch thick directly in a door.

Cut the panel to size—remember to subtract the expansion factor of 1/32-inch per foot—sand the edges, remove the protective paper and insert the panel in the door.

Tighten the clips just as you would for a drop-in sash and the job is done. If the material is too thin to be held firmly by the clips, insert thin wood spacers between the acrylic and the clips, or use spring-loaded clips.

Acrylic window panes can be cleaned with a one percent solution of liquid dishwashing detergent in water applied with a soft, clean cotton flannel or jersey cloth. Periodic waxing with automobile paste wax —use wax only; not a cleaner-wax combination—will fill most minor surface scratches and maintain luster. Apply a thin coat and buff with a soft, clean cotton cloth.

When glazing ordinary frame windows with acrylic sheeting, follow the same rules for measuring and cutting acrylic storm door panels. Be sure to use a non-hardening glazing compound or putty that will yield slightly when the acrylic expands or contracts.

Apply a thin bead of glazing compound around the frame before inserting the acrylic panel. Press the acrylic in place against the bead, insert glazing points around the frame and apply a covering bead of glazing compound as you would for an ordinary glass window pane.

See also: ALUMINUM; SHOWER DOOR; WINDOWS.

Tighten the clamps as firmly as you would for a drop-in frame. If the panel is too thin to be held firmly, insert wood spacers between panel and clamp, or use spring-loaded clamps.

Bouncing ping-pong ball demonstrates dramatic, informative photographs possible with phono-strobe. Pictures were made at identical time intervals. Careful study is warranted.

Record Action with Inexpensive Strobe

You can build this mechanical unit in a few hours and use it to analyze any action from the bounce of a ball to the way a human being runs or jumps

THE ACCOMPANYING PHOTOS of the bouncing ball and the jumping boy were made, not with an expensive electronic flash unit, but with a mechanical strobe unit built in a few hours from a broken-down portable phonograph. A simple but effective variable shutter and a slit selector provide effective controls that make strobe-photography easy for anyone.

Even if you don't own a camera, construction of this unit is still well worthwhile because it can also be used for visual observation of all kinds of motion. But if you do have a camera—any kind—try making a few pictures because they will reveal things that the eye alone is incapable of seeing.

For example, take a close look at the bouncing ball picture. Although the series of pictures were made at identical time intervals, the adjacent images are sometimes far apart, sometimes close together. The obvious reason is that the progressively increasing separations indicate acceleration because of the pull of gravity. On each upward path the ball loses speed, hence the image separations decrease until the kinetic energy of the moving ball is fully translated to a momentary potential energy at the peak of each bounce. This process is repeated several times, but the bounces are smaller and smaller as energy is used up.

Note that this picture provides highly graphic proof that the bounce curves consist of a series of parabolas. Now, suppose you were to join the *peaks* of all bounces with

a continuous line. Do these peaks represent a straight-line function? Or would this line too be a parabola? We'll leave it to you to find out by making a similar photograph. Make one showing more bounces and, if possible, enlarge the picture for analysis.

You can perform endless experiments with ping-pong balls, steel ball bearings, billiard balls and the like. For example, devise a triggering mechanism that will simultaneously drop one ball while ejecting a second identical ball horizontally. Which ball will hit the ground first? Even if you already know the answer, it will be a lot of fun proving the answer with a clear stroboscopic picture. Another problem: what happens if two balls of unequal mass collide in mid-air? What exactly happens if a hard billiard ball strikes another hard billiard ball, or a soft rubber ball, or a plastic ball such as one fashioned from putty?

The photo of the jumping boy illustrates a rather different kind of motion. Such photos of athletes or dancers could be highly revealing. Suppose that you are interested in entomology. Strobe sequences of a walking or running insect would provide fascinating insight into the ways various insects move their legs. Clearly, the experimental applications of this strobe unit are endless.

How does this mechanical strobe compare with an electronic flash strobe that costs more to build? In view of the price difference, you would expect the inexpensive mechanical device to be of limited capability. However, the practical performance differences aren't great and there are several definite pluses in favor of the mechanical strobe in addition to its low cost.

The electronic strobe will "stop" very fast motion because of the extremely short durations of the individual flashes of light. The mechanical strobe doesn't have this extreme stopping capability unless very intense light sources are used. However, it will adequately handle any moving object that normally could be stopped with camera shutter speeds in the 1/300 to 1/500 second range. The jumping boy represents a difficult test for the strobe because the action is fast, at right angles to the camera axis, and at close range of only ten feet. Yet the blurring, mainly limited to the hands, is negligible.

The electronic flash strobe does help to maintain good picture contrast, particularly with reference to separation of the subject from the background which is usually black. Using the flash, the background receives a total accumulation of light equal to the sum of all flashes during a picture sequence—usually from 20 to 40 flashes. If the electronic tube has a flash duration of, say, 1/1,000 second, this would add to only 40/1,000 or 1/25 of a second.

On the other hand, the mechanical strobe must be used with a continuous light source such as photoflood bulbs, and the total background exposure is usually a full second or more. Also, the brilliant flashes produced by the electronic flash permit the use of smaller camera lens apertures, leading to greater depth of field in sharp focus. However, careful lighting techniques and film development practices will largely overcome these limitations of the mechanical strobe.

The mechanical strobe has several definite advantages over electronic rigs. It is far easier to use for visual observations. Construction is simpler, especially for those whose knowledge of electronic circuits is limited. You don't have to work with power units that pack potentially lethal voltages running as high as 5,000 volts. Finally, you can operate the mechanical strobe for as long as you like, whereas the electronic tube must be allowed to cool after each brief flash sequence.

How it works. Basically, this strobe unit consists of nothing more than a slotted disc rotated by a variable-speed motor. On sighting through the hole near the top of

▲ *Complex motions like this boy jumping can be photographed and analyzed with ease. To the imaginative, experimental applications of this strobe unit are endless.*

the projecting panel, you get periodic glimpses of the moving object as the disc spins.

However, this unit is handier to use than the usual moving-slit strobe because it features three superposed discs rather than the usual one disc.

It is obvious that the faster the disc spins, and the more slits it has, the more images you will see or photograph in a given period of time. By adjusting the number of slits and the disc speed, you can either spread out or compress the images you photograph. For example, a faster disc speed would have packed more balls into the bouncing ball picture although the overall pattern would have been the same. A slower disc speed would have given fewer balls, spread further apart.

Choice of motor. If you happen to have a 400 to 600 rpm variable-speed, rheostat-controlled motor, you have an ideal power source. With a little ingenuity you could fit a non-variable motor with a mechanical speed control by fitting a small rubber wheel onto the motor shaft and allowing this to impinge against a cone (made from wood or preferably hard rubber) attached to the disc shaft. By moving the motor back and forth along some sort of guide track, so that its drive wheel touches various parts of the cone, you will be able to vary the speed of the disc continuously.

A simpler solution, and one wholly sat-

isfactory for most experimental needs, is to use an old phonograph motor. You may have an old phonograph in the attic, or may be able to find one in a local thrift shop, or perhaps the radio supply store. Or you can buy a new one for less than $10 from one of the larger radio supply houses.

The 33,45,78 rpm lever on the motor will give you stepped control of the disc speed. This is entirely adequate for photographic purposes, although it does impose some limitations on visual observations. You can obtain additional speed control by plugging the strobe into a powerstat variable transformer when finer adjustment of speed is desirable.

Motor modification. Take the phonograph apart, discarding the speaker, tone arm, record table and chassis. Hang on to the amplifier unit because you may need it to step down voltage for the motor.

Note that the rubber-rimmed drive wheel that normally engages the inside rim of the record table impinges against a capstan rod having three sections with different diameters. The shift level makes the wheel move from one part of the capstan to another to effect speed changes.

Remove the drive wheel temporarily and bolt or screw a 1¼-inch length of 1¼-inch diameter wood dowel to it as shown in the drawing. First drill three holes into the wheel, then mark corresponding holes on the end of the dowel and drill holes of such size that ¾-inch long bolts can be force-threaded into the wood. Cut off the bolt heads so that they can take nuts. If the rim drive wheel is so mounted on the motor chassis that you can get at the back side of the wheel when it is in place, you can use screws instead of bolts. You may have to hollow out the end of the dowel a bit to accommodate the end of the rim wheel mounting shaft so that the dowel will lie flush against the wheel.

Set a single bolt on the other end of the dowel (exact center), cut off the bolt head, and fit with a wing nut to hold down the discs.

When the dowel is attached to the wheel, mount the motor on supporting wooden blocks so that the dowel end projects

RELATIONSHIP OF DISC SPEEDS AND NUMBER OF SLITS TO THE NUMBER OF IMAGES PRODUCED

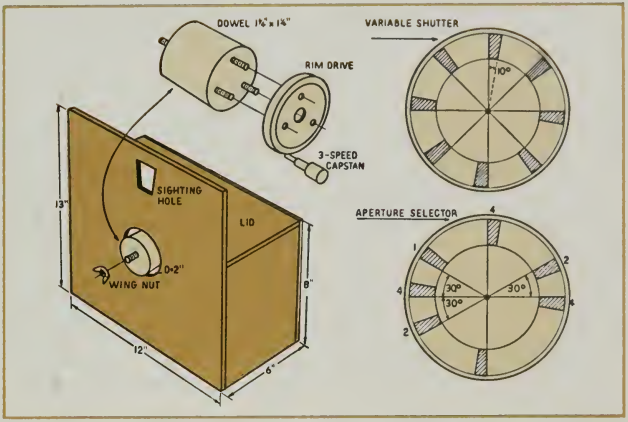
Disc Speed	Rev. per minute	Rev. per second	Number of images per second			
			1 slit	2 slits	4 slits	8 slits
H (high)	297	4.95	4.95	9.9	19.8	39.6
M (medium)	171	2.85	2.85	5.7	11.4	22.8
L (low)	127	2.11	2.11	4.2	8.4	16.9

NOTE: This table may not be applicable to all types of phono motors. Text tells how you can prepare a similar reference table for your strobe.

SHUTTER SPEEDS IN TERMS OF DISC SPEEDS AND SLIT WIDTHS

Disc speed Setting	Rev./sec.	Seconds per 1 revolution	Exposure in seconds			
			10° slit	7.5° slit	5° slit	2.5° slit
H	4.95	0.20	1/180	1/270	1/360	1/720
M	2.85	0.35	1/103	1/155	1/206	1/412
L	2.11	0.47	1/77	1/115	1/154	1/308

NOTE: Text tells how to prepare your comparable table if your H, M and L speeds in revolutions per second differ from these values.



▲ *Strobe components. Note that capstan rod has three sections of different diameters. Shift lever makes rubber-rimmed drive wheel move from one to another for changes in speed.*

➤ *Two eight-aperture discs are held on drive shaft fitted with bolt and wing nut. Here discs are registered to provide maximum aperture. By shifting the discs, all of the holes are closed down by the same amount so that you obtain any width that you desire.*

slightly through the front of the box panel when the speed is 78 rpm.

Specifications on the motor used here indicated that it was meant to operate at a maximum of 90 volts, and would burn out if plugged directly into the usual 118-volt house line. Actually, the operating voltage was found to be closer to 50 volts than 90. The required voltage step-down was solved by simply keeping the motor attached to the sound amplifier which was part of the original phonograph. An on-off switch was placed in the power line and mounted on the rear of the box.

Orient the hole through which the dowel projects out of the box in such a position that the motor's speed control lever projects upward through a hole cut into the box cover, as shown in the photograph.

Label the three speed positions with the letters H, M and L to indicate High, Medium and Low speeds. The original 33, 45 and 78 designations no longer have any meaning. Alternatively, you can calibrate the actual disc speeds and mark these at the appropriate lever positions.

Disc construction. The drawing shows the two types of discs to be constructed from poster cardboard that is black on both sides. Make two identical discs for the variable shutter. The slits have an angular width of 10° and are about 1⅝ inches high.

When these two discs are mounted atop each other on the dowel, they can be rotated with respect to one another to vary the slit widths from the full 10° to very narrow slits. Variation of the slit widths together with changes of disc rotation speeds determine the strobe's "shutter speeds."

The aperture selector disc is mounted atop the other two discs. By shifting this disc you can quickly expose 1, 2 or 4 slits as needed. To use all 8 slits remove the third disc.

To eliminate all possible stray light reflections, paint the cut edges of the slits with black paint or ink.

Mount the completed discs on the dowel, then mark off the position of the top slit on the front panel of the box. Cut a similarly shaped hole in the box panel, but make it a bit larger than the slits in the discs. Paint the hole edges black.

You are now ready to make visual observations with the strobe. Just sight through the sighting hole at a moving object while the discs rotate. Unless you add a rheostat control, or have used a continuously variable motor, you will not be able to accurately "synch" the disc speeds with the speeds of the moving subjects you observe to make them appear to stand still. However, this generally is not a serious shortcoming because a substantial slowing down of the apparent motion is all that is usually needed. In strobe photography, there is even less need for perfect synchronization.

Photographic techniques. To make really good pictures using this strobe unit you need to understand the interrelations of the following factors: (1) the number of slits on the disc; (2) the width of the slits; and (3) the speed of disc rotation.

The three diagrams will make these relationships clear. The first diagram shows what happens when 2, 4 or 8 slits are used to photograph a projected ball. During each revolution of the disc the same number of images are formed as there are slits on the disc.

The second diagram shows what happens if the slit is made narrower. The number of images formed remains the same, and they will appear in the same relative positions on the film, provided the disc speed and the speed of the moving object remains constant. However, the narrower slit produces a sharper image because the ball has less time in which to move across the field of view during each individual exposure period. Changing the slit width is just one way of altering the strobe's shutter speed. As in ordinary camera work, when

PROBLEMS AND CURES IN STROBE PHOTOGRAPHY

Problem	Remedy
BLURRED	Narrow the slits or increase disc speed or do both. Check camera focus.
TOO FAR APART	Increase the number of slits, speed up the disc, or do both.
TOO CLOSE TOGETHER	Reduce the number of slits, reduce the disc speed, or do both.
TOO CLOSE TOGETHER AND BLURRED	Decrease the number of slits and make them narrower. Slowing the disc speed to spread out the images would lead to greater blurring.
TOO FAR APART AND BLURRED	Increase disc speed and/or increase the number of slits, making them narrower if the disc speed is not increased.
FAINT AND LACKING IN CONTRAST	Use larger camera diaphragm aperture. Use wider disc slits if image blurring does not result. Use brighter lights to illuminate the subject. Boost picture contrast by overdeveloping the negative or by using a high contrast developer such as Kodak D-11 formula.
TOO DARK	Adjust for overexposure by closing down the camera diaphragm, reducing intensity of the illumination on the subject, or narrowing slit widths which would also help to sharpen the image.

you increase the shutter speed—i.e. narrow the slit—you must compensate by increasing the intensity of the illumination or by opening the camera lens diaphragm wider to admit more light.

Suppose you maintain the same number of slits and keep them at the same widths, but increase the speed of disc rotation. The third diagram shows what would happen in a given time interval if the disc speed were to be doubled. The slits in the top line are shown wide at the bottom to indicate that they are in reality the same width as in the bottom line; the tops of the slits are shown narrower to graphically indicate that the apparent effect of increased disc speed is similar to that obtained by using narrower slits.

The images are sharper because the increased disc speed is the second way to increase the strobe's shutter speed. But there is a significant difference: increasing the shutter speed by increasing disc speed leads to production of more images per given time interval whereas increasing the shutter speed by narrowing the slits keeps the number of images produced unchanged.

Study these relationships carefully because they will help you to solve two basic problems in every strobe photo project: (1) how to balance the number of slits, slit widths and disc speeds to expose the film properly and (2) how to balance the number of slits and the disc speeds to control the spread or compression of the successive images produced on the film.

Image frequency. With experience you will be able to adjust the strobe to give you any desired spread of images across the picture. Too many pictures, too close together, cause undesirable overlapping whereas too few pictures will not provide the amount or detail of information sought.

The number of images you obtain per second of action depends on the disc speed and the number of slits used. The speed of moving object will also affect the total number of images that will appear on the film.

You can predict the final results much

more accurately if you prepare a table similar to that shown which records the relationship of disc speeds and number of slits to the number of images produced.

The circumference of the rim drive wheel to which the wood dowel was affixed was found to be 6½ inches. The inside circumference of the record table was 24¾ inches. By solving the following simple inverse proportion the rpm of the rim drive wheel was calculated for the original 78 speed:

$$6.5 : 24.75 = 78 : X$$

$$X = 297 \text{ rpm or } 4.95 \text{ rps}$$

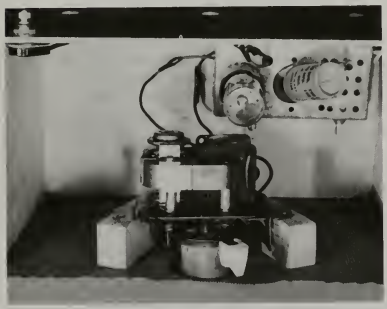
By substituting 45 and 33.3 for 78 in the proportion, the corresponding speeds for medium and low settings were obtained.

All that needs to be done now is to multiply each rps value by the number of slits available to complete the table. You can, of course, amplify the table by adding values for 3, 5, 6 and 7 slits if you wish.

Suppose, for example, that preliminary tests show that the object in motion will move across the camera's field of view in 1 second. The table immediately shows that at high-speed you will get almost 40 images using 8 slits but only about 10 using 2 slits. If the total action takes 2 seconds to move across the field of view, you will, of course, obtain double these numbers of images.

Shutter speeds. Although you will use the diaphragm in your camera to control the amount of light reaching the film, you will ignore the camera's regular shutter speeds because you will hold the shutter open on "bulb" or "time" whenever making a strobe sequence. The slits in the strobe discs now become the shutter, and the effective shutter speeds will depend on two factors: (1) speed of the disc and (2) slit width.

You can use shutter speeds as fast as 1/700 second even if you use a simple camera having shutter speeds under 1/100



Interior of box shows how motor is mounted on two wooden blocks. Amplifier of original phono steps down voltage to that motor requires. On-off switch is at a top left.

Rear of main panel. Note camera and sighting opening, box-lid cut-out for access to speed control. Indicated are high, medium, low speeds; 33, 45, 78 are now meaningless.

second. If you gear up your disc speeds even more, or use still narrower slits (provided you have sufficiently bright illumination available) you can use still faster motion-stopping shutter speeds.

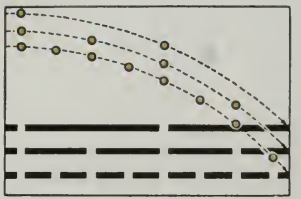
To determine how to set disc speeds and slit widths to obtain any desired shutter speed use the table for shutter speeds in terms of disc speeds and slit widths if the discs on your rig run at approximately the same speeds. If your disc speeds are substantially different, make up your own shutter speed table.

For example, a disc speed of 4.95 revolutions per second means that it takes the disc 0.20 or 1/5 second to make one complete revolution. A slit with a 10° angular width obviously represents 1/36 part of a full revolution. Hence the exposure time, using a 10° slit at this disc speed is 1/5 x 1/36 or 1/180 second. A 5° slit would move past the lens in just half this time.

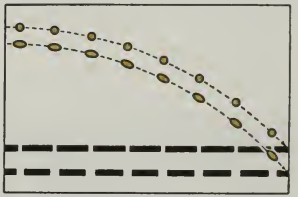
You can calibrate your two variable shutter discs with whatever degree of refinement you wish. But it is wholly adequate to mark only those overlapping positions of the discs which will provide a full 10° opening, a ¾ full opening, a half open slit, and one opened only ¼ the way.

Exposure calculations. When you are ready to take a picture, take an exposure meter reading of the subject in the usual manner. Suppose that the meter indicates you should expose about 1/350 second at *f*/4. Set the camera diaphragm at *f*/4 and run the disc at high-speed with 5° slits as indicated by the table.

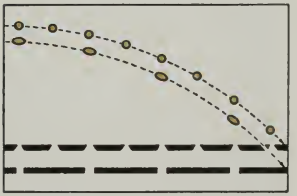
The only other thing you have to figure out is how many slits to use to obtain the best distribution of images on the film. If the total action takes 1 second and you want about 10 images spread across the film, according to the table, you should set your aperture selector so that you will only use 2 slits, which will give you 9.9 images per second when using a high disc speed. Always use the fastest film available.



Number of images produced in one revolution of the disc depends on number of slits in the disc. Black bars here and below are poster cardboard; white breaks are slits.



Images become sharper and clearer as slits are narrowed. Alteration of slit widths will not change the number of images that are produced during each disc revolution.



Boosting disc speed yields more and sharper images. Here, slits are identical but faster top ones act as if narrowed. Images are sharper and more numerous.

Picture contrast. If you want really sharp prints, you will have to work for good contrast. Prepare your set-ups to achieve the blackest backgrounds possible. Use a large black cloth set well back from the subject. Some people advocate putting the subject in front of large open door to let the extra light expend itself in a darkened room behind the subject. You can even do your shooting out-of-doors, at night, letting the light overspill get lost in the outdoor expanses.

The following case histories may help you in your preliminary experimentation.

Case I—Bouncing Ball. A large black cloth was used as a background. The ping-pong ball was allowed to run down a cardboard V-shaped trough so that it bounced on a long bench also covered with black cloth. The camera shutter was opened just before the ball emerged from the trough and was promptly closed when the action was over. Two floodlamps were used for lighting, these being set off in front and to each side.

A meter reading taken from a standard grey card indicated an exposure of about 1/250 second at *f*/4.5. The camera diaphragm was set at *f*/4.5 and the disc was run at high-speed using four slits at 7.5° The Tri-X Pan film was developed in D-11 developer for 5 minutes. The negative was printable on contrast paper, but a bit more exposure of negative would have been better.

Case II—Jumping Boy. The boy was dressed in very light colored clothes and was asked to jump over a box in front of a black cloth background. Even frontal illumination was provided by four flood lights. Exposure on Tri-X Pan sheet film was calculated at 1/250 second at *f*/4.5 by meter reading. The disc speed was set at high, and two test shots were made using a 10° slit (1/180 sec.) and a 5° slit (1/360 sec.). Both were very printable negatives, but the 1/360 second shot was preferable.

If four slits had been used as in the preceding case, the images would have overlapped too much because of the relatively large size of the boy compared to the ping-pong balls. The desired image spacing was achieved using only one slit.

The negatives were developed for 6 minutes in D-11 developer; both printed well on normal contrast paper.

You will find this simple strobe unit a fascinating tool for visual and photographic scientific experimentation. If you happen to work with optical color discs you will increase optical phenomena you will see by viewing the illusions through this strobe unit.

J.H.

Plastic box on lid of unit brings camera lens to the proper level for shooting strobe photographs. Note ventilation holes in box.

See also: MACROPHOTOGRAPHY; PHOTOGRAPHY; PHOTOMICROGRAPHY; SCIENCE PROJECTS.

How to Repair Stucco Surfaces

Damaged stucco walls, even those with nothing more than hairline cracks, are vulnerable to moisture. Early attention can save you from costly repairs later on

Damaged stucco should be repaired as soon as possible so weathering will not cause hairline cracks and larger openings to develop into major repair jobs.

EARLY REPAIR of damaged stucco walls is essential. Moisture can get between the coats of stucco, even through hairline cracks, and cause serious damage.

Although stucco makes a tough wall, a blow from a car bumper or rock can crack one or more of the three coats. Corners are especially vulnerable, particularly those near a driveway.

With tools as a hammer, cold chisel, screwdriver, whiskbroom, block of wood, finishing and pointing trowels, scratcher, and a wooden tray with a handle called a plasterer's hawk, you can be sure of getting a surface that will match the existing wall.

Materials needed to repair small hairline cracks are Portland cement and No. 1 torpedo or masons sand. Larger cracks and damaged areas can be repaired with premixed stucco cement or plastic cement. Don't add anything as fine as plaster sand to your mixture, because this would cause fine cracks to appear in the surface when it dries. Coarse sand used in concrete would make the finish too grainy.

Plastic cement consists of Portland cement with a plasticizing agent ground into it to make the mix more workable. If this is not available, you can add a plasticizing agent to regular cement. They include hydrated lime, diatomaceous earths, finely divided clays, asbestos flower or fibre, or lime putty. Use one part cement, three parts of sand, and not more than 10% by volume of plasticizer.

If any doubt exists about getting a good bond between the new work and the original surface, get a bonding agent. Brush this on the old surface and mix it with the new mortar.

All ingredients should be well mixed. Work the dry cement and sand together for at least 10 minutes, and for the same length of time when water is added. Use clear water, good enough to drink, and only enough to give you a stiff batter.

Fill small cracks with a mixture of one part Portland cement and two parts sand. All other work calls for one part Portland cement, or cement with a plasticizing agent and two and a half parts sand.

Pre-colored walls can be repaired with a factory colored stucco cement. If you can't get the right color, however, you can mix

stucco patching: see masonry
subfloor installation: see garage remodeling
subsoil irrigation: see gardening
sunfish: see fishing
sun-sauna chaise: see chaise

your own. For a white wall use white Portland cement and silica sand. Use high-grade mineral pigments for the other colors, such as burnt oxide or Germantown lampblack for gray, chromium oxide for green, red oxide of iron for rose, and yellow oxide of iron for cream.

Mix only a small amount of color pigment into the dry cement and sand until it matches the existing wall color before adding water. The mixture will turn darker when wet, but after the patch is cured and dried the color will blend with the surrounding surface.

Uniform suction is necessary to get a proper bond between succeeding coats of stucco, or when the first coat is applied to a masonry wall. Suction is caused by the base or underneath coat drawing water from the new coat.

This drawing process must be slow and uniform. If you apply the new coat over a dry surface the water will draw out so rapidly that it will be weak and crumbly. Get uniform suction by dampening the base surface until it absorbs all the water it can. Don't soak it until the surface gets spongy. Use a fine fogging spray and keep dampening the surface ahead of the work.

On masonry walls the base must be roughened and cleaned before dampening. On wood-sheathed walls there is no suction possible for the first coat so it is important to start the scratch coat with a wire mesh or metal lath base. After the first coat is cured and dried, you can get suction for the succeeding coats by dampening the base.

Careful curing is an important factor in making a good stucco wall or patching job. Keep each coat damp for at least two days after it's applied. Cover the repair with a damp burlap bag to hold moisture in on hot days when the humidity is low.

Let the surface dry for a week before redampening and applying the next coat. It is best to let the second coat dry for two or three weeks before applying the final coat. This way any cracks that show up can be covered with the finishing coat.

Repair hairline cracks by enlarging the crack with a screwdriver or chisel until you have an opening down to the solid surface of the existing wall. This gives the patching material a firm base to fasten to. Dampen the opening to build up suction.

Use a rich mixture of one part Portland cement and two parts of sand for crack repair. Add water until a stiff batter forms and fill the crack by pressing the mortar in with a trowel. When the patch begins to harden, use a whisk broom to remove excess mortar, and scratch the surface. Trowel the final ⅛-inch coat to match the existing wall surface. Let the surface dry and paint it if you haven't added a color pigment to the mixture.

Major damage that goes through to the base surface requires the full treatment of three coats of stucco. First remove the damaged stucco down to the base, then build up suction by dampening. Apply the first, or scratch coat to the wall about ⅜-inch thick. When the mortar begins to harden, scratch it horizontally and vertically to give the surface a waffle iron look.

You can use a garden rake as a scratcher, or make one by driving 8*d common* nails 1-inch apart through a block of wood. A single nail or a screwdriver can be used to roughen a small surface.

After the first coat is thoroughly cured, dampen it again to build up suction for the second coat. This second coat should be ⅜-inch deep, and come to within ⅛-inch of the finished surface.

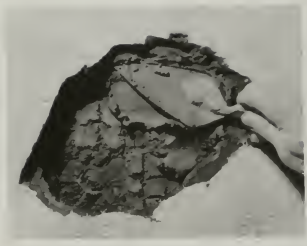
Damage seldom goes beneath the second coat in stucco walls built over metal reinforcement. Remove the damaged stucco with a cold chisel down to the metal reinforcement and brush out loose mortar with the whisk broom. Prepare the base by building up suction, then work the filler between the metal reinforcement and against the base coat of stucco.

When the second coat begins to set up, float it with a block of wood. Work the surface with a circular motion to level and roughen it. This coat should not be worked more than is necessary to secure proper density. Over-troweling tends to bring the cementitious material to the surface and crazing and map-cracking are likely to result. Sometimes, instead of floating, the surface can be lightly scratched with a whisk broom to provide a bond for the finish coat.

Cure the second coat with a spray of water and let it dry for 7 to 10 days, then apply the ⅛-inch finishing coat. While the finish is still damp, texture it to blend with the type of finish that exists on the surrounding area.

A simple method of texturing is to brush the finish coat with a whisk broom while it is still damp. Another way is to work the repaired surface with the finishing trowel that is held flat.

Damaged corners can be repaired by cleaning out the opening with a screwdriver or cold chisel, then moisten the area to be repaired with a fine spray of water. Unless the damage goes through to the base, only two coats of mortar have to be applied. Use a small board to square off the corner when you force in the mortar. Keep this coat from ¼- to ⅜-inch below the finished surface.



▲ *Metal reinforcing mesh often prevents damage from going beneath second stucco coat.*

▲ *Hold finishing trowel flat when you blend the repaired area into surrounding surface.*

▲ *Before applying each coat of stucco, evenly dampen the base coat to control suction.*

◀ *Enlarge hairline cracks with a screwdriver or chisel, so the mortar can adhere to the solid surface of the existing wall.*

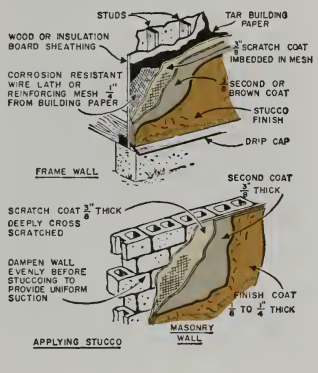
Scratch or roughen the mortar when it begins to harden. Let it cure for 7 to 10 days, then use a larger board held flush with the existing corner to true-up the finish.

Like brick veneer, stucco can be applied over a frame wall or any type of masonry surface. You must work from the base up when replacing a window or door with a stucco surface.

On masonry walls the stucco is applied directly to the surface. On wood frame walls the new surface must be covered with waterproof building paper and a metal reinforcement that is similar to that used on the existing wall. Make a 4-inch lap to join the two papers and seal it with waterproof paint.

Fasten the mesh with furring or stucco mesh nails. These fasteners have ⅜-inch fiber washers on them to hold the wire away from the paper so the mortar can get behind it to ensure a good grip. After you have applied the three coats of stucco, use a rubber base masonry paint to increase the weather seal of the new surface. P.A.C.

See also: CONCRETE; HOME IMPROVEMENT; MASONRY; SIDING.


STUDS
TAR BUILDING PAPER
WOOD OR INSULATION BOARD SHEATHING
⅜" SCRATCH COAT IMBEDDED IN MESH
CORROSION RESISTANT WIRE LATH OR ½" REINFORCING MESH ½" FROM BUILDING PAPER
½" SECOND OR BROWN COAT
STUCCO FINISH
DRIP CAP
FRAME WALL
SECOND COAT ⅜" THICK
SCRATCH COAT ⅜" THICK DEEPLY CROSS SCRATCHED
DAMPEN WALL EVENLY BEFORE STUCCOING TO PROVIDE UNIFORM SUCTION
FINISH COAT ⅛" TO ¼" THICK
MASONRY WALL
APPLYING STUCCO

STUCCO FINISHES

Three simple finishes are: a troweled surface which is relatively slick; a floated finish which is grainy; and one made with a bonding cement paint. There are, however, seven standard finishes, and here are the ways to get them:

Spanish texture. Made by applying the finish coat in heavy layers, making strokes in all directions. Smooth out rough edges with a round-point trowel before the mortar hardens.

California texture. Put on in gobs with the trowel. Before the mortar hardens, rub the surface down with a wad of burlap to produce a wavy, irregular, coarse surface. To finish, trowel the surface creating highlights.

Italian texture. Over a thin final coat, dash on small quantities of mortar with quick strokes of a whisk broom. To finish, place your trowel flat against this dash coat and draw evenly across the wall from left to right. Smoothing return strokes erase possible trowel marks.

English Cottage texture. Over a ⅛-inch thick finish coat add small amounts of mortar, feathering the edges with a twisting motion. Apply in all directions to get the random rough effect.

Colonial texture. Apply a thin finish coat over the second coat. Allow to dry long enough so the grainy texture will not rub off when you go over it with a wood float or block of wood covered with a piece of carpet. Surface may have to be dampened.

Modern American. Let the finish coat be ¼-inch thick. Stroke the surface upward with the edge of a block of wood. Don't worry about trowel marks.

Italian Travertine. The troweled finish should be fairly smooth. Use a whisk broom to pull up an irregular texture, then trowel the surface while it is still workable.

Most surfboard damage consists of crecks, punctures and gouges; all easily repaired.

Keep Your Surfboard in Top Condition

Salt water can attack the foam or balsa core of your board. Keep it out by repairing nicks, gouges and scratches with this easy method

SOONER OR LATER every surfboard receives some kind of damage. Boards have been broken in two by powerful waves, but the more commonplace problems are the cracks, gouges and dents that occur when boards strike rocks, pilings and bulkheads.

Storing and transportation are also a source of damage. Dropping a shovel or some other hard, heavy object on a surfboard kept in a garage can be as damaging as letting it get dashed against rocks.

Punctures and other breaks in the skin should be repaired promptly because salt water will rot the foam core of the board. Pour hot wax on the damaged spot for a quick emergency repair. A lasting bond requires resin and glass fiber cloth.

To make a permanent patch, trim any loose glass fiber skin away until a solid bonding with the foam is present all the way around the damaged area. Sand the edges of the damaged portion until the edges are smooth and taper into the solid material. Roughen the surface of the foam or balsa core to achieve a reliable bond.

Use a surfboard repair kit or an automobile body repair kit. Cut a patch of glass fiber cloth somewhat larger than the damaged area. The patch should overlap onto sound material for at least an inch in all directions. Combine resin and catalyst, according to repair kit instructions. Use a paper cup or other disposable container. In a puncture, some resin should first be poured into the hole in the foam. Resin pig-

surfboard, motorized: see runabouts

Loose glass-fiber skin around a patch would soon split or delaminate. The first step is to remove it until a solid bond between skin and core is reached.

ment can be added to match surfboard color.

Place the patch over the damaged surface or filled hole and apply resin mixture with a piece of plastic or small brush. Work outward from the center of the patch, saturating the cloth thoroughly and leaving no air bubbles or wrinkles. Avoid soaking the overlap. The patch should cure for an hour in hot sun until no longer tacky, or overnight.

Use a sanding block, orbital or vibrating sander to remove rough edges and bring patch down to level of the board surface, working from rough to fine paper. A belt or disk sander might cut too rapidly.

Combine a small amount of resin and catalyst and apply lightly over surface of the completed patch. When this coat has cured, a light sanding with very fine paper will complete the finish. An old, much used surfboard will acquire hairline cracks, depressions and scratches, while taking on a generally ragged appearance.

The surface can be strengthened and renewed. First sand the board thoroughly with #50 grit emery cloth. This provides a good surface for the covering coat of new resin. Mix a pint of boat polyester or epoxy resin with the recommended measure of catalyst to control the speed of hardening.

Just before application, mix in several ounces of resin pigment to match the board's color. This pigment tends to retard the cure. Pour mix over the sanded surface of the board and let it flow out evenly. Only edge drips may need final sanding.

Sand the edges of the damaged spot until they are smooth and taper into the solid material. Roughen surface of foam or balsa core.

Cut a patch of glass fiber cloth that is at least one inch larger than the damaged area all around.

If the damage is a puncture, pour some resin-catalyst mixture into the hole before applying the patch.

Lay the patch over the damaged area and apply resin-catalyst mixture over it with a brush or spatula.

Smooth the resin-catalyst mixture into the patch, pressing the patch against the board and working out any bubbles.

After the patch has cured, sand the patched area smooth, working from rough to fine grit. An orbital or vibrating sander is suitable. Do not use a belt or disk sander. Either of these might cut too rapidly.

Make Yourself Freeze-proof

You can enjoy camping in winter, if you dress and equip yourself properly, and are alert to the onset of frostbite or hypothermia

KEEPING WARM is a matter of applying basic principles. There are no exotic formulas involved; just a few guidelines and common sense.

First of all, keeping warm is not merely a matter of comfort. Your vital organs need warmth in order to function properly. If you allow any part of your body to lose too much heat, you're inviting hypothermia, frostbite, and in extreme cases, death.

Low air temperature, of course, is the first indication you'll have of the need to keep warm. Wind speed may not be as obvious, but must be taken into account whenever you venture outdoors. Wind magnifies the chilling effect of cold air. Moisture, too, must be considered. Water destroys the insulating value of virtually all clothing, and, at the same time, cold water robs you of more heat than cold air.

Keeping warm is in part a matter of protecting yourself from cold air, wind and water. Pick the right clothes and you're off to a warm winter. Here are a few tips.

Wool retains more of its insulating power than any other natural or man-made fiber when wet, and is a better insulator than most fabrics when dry.

Body heat can be lost through any and all parts of the body. Strange as it may seem, wearing a hat will help keep your feet warm.

Layers of clothing allow you to adjust to changes in weather or activity, and generally insulate better than single, heavy garments. You don't want to work up a sweat when it's cold. The moisture robs you of heat and your clothing of insulating power.

Ounce for ounce, down-insulated garments are warmer than any other type of garments.

Keep clothing dry. If garments should get wet, dry them off at the first opportunity. This is essential with down-filled clothing.

Keep active. If, in spite of your warm clothing, you find yourself getting chilled, it's time to start generating more heat. Get moving. Run in place, touch your toes, get into a snowball fight, have a tug of war—anything that requires physical effort will generate heat and keep you warm. You just have to know when to stop—short of perspiration.

If you're sleeping out, a sure way to warm up your sleeping bag before you go to sleep is to do some kind of exercise in the bag. Merely changing long johns while the sleeping bag is tightly zippered will often do the trick. If not, try raising and lowering your legs, pedal in reverse, (pedaling normally will tend to uncover you) or try lifting yourself off your back. In short

suspended ceiling: see ceiling tile
suspension system: see garage door, overhead
sweating, toilet tank: see toilet
swell-front cabinets: see drawers

order, you'll have the extra warmth you want.

Calorie intake. Warm clothing and exercise will keep you reasonably warm for many hours. For prolonged exposure to the cold, remember to take in extra calories to compensate for the extra calories your body is burning up.

Adding heat to the body, whether in the form of calorie-rich food or hot food, helps save your energy reserves. Don't neglect liquid intake (or salt, which helps retain moisture in the body). In fact, increase your consumption of hot liquids. First of all, you need to replace body fluids that are lost when you are active. Secondly, hot liquids have a higher heat value than hot solids. If you set out a cup of hot mashed potatoes and a cup of hot coffee, you'll find that the coffee stays hotter longer.

Protect campsite. When you pick a site for your tent or recreational vehicle, pick one that is shielded from the wind. If you have to park your RV or pitch your tent in a windy spot, place it so that the wind doesn't blow directly into a doorway. If there's snow on the ground, you can pack it along the sides of a tent to prevent wind from getting under the floor. If snow is unavailable, logs, rocks and other debris can be used for this purpose.

When tent camping, pick a tent that is big enough to cook in. There will be times when the weather won't allow outdoor cooking, and you should not go without hot food.

At the same time that your tent should allow cooking, it should be small enough to heat easily. Double wall (full fly) designs are best because they offer better insulation. Thermal tents should make staying warm less of a chore.

Normally a small lantern or candle, along with your body heat, will provide enough warmth for comfort inside a small, sheltered tent down to about 25 degrees, even colder if you're using the tent just for sleeping and have a good sleeping bag.

As this chart illustrates, wind speed magnifies the chilling effect of cold air. Even on calm days, a snowmobile's speed can generate considerable relative wind. Dress accordingly with windproof garments.

WIND CHILL CHART

WIND SPEED (miles per hour)	AIR TEMPERATURE (°F)						
	+30	+20	+10	0	−10	−20	−30
	TEMPERATURE EQUIVALENT						
10	+16	+2	−9	−22	−31	−45	−58
15	+11	−6	−18	−33	−45	−60	−70
20	+3	−9	−24	−40	−52	−68	−81
25	0	−15	−29	−45	−58	−75	−89
30	−2	−18	−33	−49	−63	−78	−94
35	−4	−20	−35	−52	−67	−83	−98
40	−4	−22	−36	−54	−69	−87	−101

Cold
Very cold
Bitterly cold

Uncovered flesh freezes in one minute
Uncovered flesh freezes in thirty seconds

(Modified from the U.S. Army Wind Chill Index)

For colder weather, or larger tents, a good heater of some kind is advisable. *Whenever you are using a heater, stove or lantern in an enclosed space, you must have good ventilation.* Even if you're using a device which doesn't give off carbon monoxide, oxygen is being depleted.

Because tents are flammable, considerable care must be taken in selecting and using a heater. The safest heaters are propane catalytic heaters; gasoline and alcohol fueled catalytics are next in line for safety. Remember that when using a catalytic heater you must light the heater outside, away from any flammables. Remember too to keep the heater away from the tent wall and any other flammables.

It is not safe to go to sleep with a heater on in the tent. At night, your sleeping bag plus residual heat in the tent must keep you warm. You can help the situation considerably if you use a foam or ensolite sleeping pad under the bag—a full-length pad at that. An air mattress is better than no under-bag protection at all, but much inferior to foam in its insulating properties.

Other "warm sleep" tips:

Sleep with a hat on—a wool "watch cap" is great.

Just before getting into your sleeping bag, have a cup of hot tea or cocoa.

Place clothes under the sleeping bag, on top of the foam pad.

Sleep with fresh, dry socks and underwear.

Place extra blankets *inside* the sleeping bag, to preserve loft (and insulating power).

If the extra warmth is needed, a pocket hand warmer or Therma-Pak will supply extra heat safely.

Caution. Hypothermia, subnormal body temperature, is a dangerous—and sneaky—condition. It robs you of reasoning power and can lead quickly to death. Your best line of defense against hypothermia is to stay dry and warm. If you should get wet or too cold, *get out of the weather!* Dry off and warm up completely before going out again.

Watch out for each other. Symptoms of hypothermia are: 1) Uncontrollable fits of shivering. 2) Vague, slow, slurred speech. 3) Memory lapses. 4) Frequent stumbling, lurching gait. 5) Immobile, fumbling hands. 6) Drowsiness. 7) Apparent exhaustion—inability to get up after a rest.

Frostbite is another cold-weather hazard to watch out for. The best defense against frostbite is to keep warmly dressed. Warm boots, mittens and ear-covering hat are musts, and a ski mask is a good idea if it's very windy.

First symptom of frostbite is pain in the extremities, often accompanied by paleness. Warm the extremity immediately, and get back into shelter. The pain is your last warning that serious damage to the flesh is about to take place.

Eventually the pain will be replaced by numbness—no feeling in the fingers or toes at all. At this point the condition is extremely dangerous and may result in permanent damage. Immediately get into shelter and summon a doctor.

Treatment—the only treatment—for advanced frostbite is to warm the injured part in warm (not hot) water. DO NOT BELIEVE THE OLD WIVES' TALE ABOUT RUBBING THE INJURED PART WITH SNOW! Do not rub the injured part with *anything.*

As the injured extremity thaws out, extreme pain will set in. The patient will be unable to proceed under his own power, and this is why it is essential to be in a shelter and have a doctor on the way.

Nothing this extreme should ever happen to you. Just remember that camping is supposed to be fun, and if you're too cold to enjoy yourself, you're too cold to be out. K.G.

See also: CAMPING; CRAFTSMANSHIP; FIRST AID; HIKING; TENTS; WEATHER; WIND GAUGE.

▲ *The common plastic bag could save your feet from frostbite this winter. You will need four bags. Put the first bag over your inner sock.*

Protect Your Feet from Frostbite

How four plastic bags—the ordinary kind used around the kitchen—can keep your feet warm when the mercury drops below the freezing point

IF YOU SHOULD FIND yourself caught in the back-country in icy conditions, four plastic bags could save your toes or your feet. They can be used to form a "double vapor barrier," the principle used in the U.S. Army's Korea boots. The principle is simple—any insulator loses most of its capacity for retaining warmth when it becomes wet, and between wet ground and perspiring feet, socks are usually pretty damp. When you add this to a cold weather emergency, it's not surprising that the feet are often tragically frostbitten.

If, like most sportsmen, you wear a heavy pair of socks over a lighter pair, you can help to protect yourself against frostbitten feet by carrying four light plastic bags large enough to fit over the feet. You can then keep the outer socks dry and effective by wearing the plastic bags inside and outside the outer socks. The outside bag prevents moisture entering the boot from wetting the sock, and the inside bag keeps the sock from becoming soaked with sweat. Roll the two bags together at the top and tuck them in to form a seal. This double vapor barrier will fit unnoticed in a corner of one of your pockets—and it might save your feet.

Also, wind increases the effect of cold on your entire body—a windbreaker can help warm the feet. R.A.B.

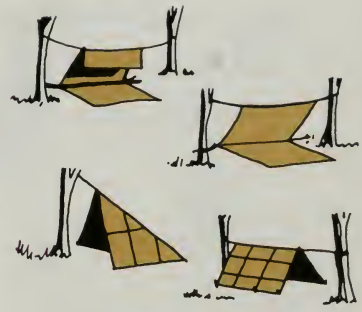
See also: CAMPING; CRAFTSMANSHIP; FIRST AID; HIKING.

Carefully work out all wrinkles in the bag so that it fits the foot snugly. The next step is to pull on your heavy sock.

The second bag is worn over the heavy outer sock. It will prevent moisture entering the boot from wetting the sock.

Tuck the outer layer of the plastic bag over the sock to seal out the moisture. In order to form a seal, roll the top of the two bags together as shown.

Emergency Shelters for Hikers



If you have no tent, improvise with a ground cloth, poncho, or a roll of plastic sheeting

IN SOME PLACES the backpacker might eliminate the tent by using a three-sided trail shelter which has been located along many trails for the convenience of hikers. These shelters follow a general pattern. A slightly raised platform in back is to sleep on and can accommodate from eight to a dozen people, depending on the size of the shelter and the people. In front is a firepit usually with a larger back rock to reflect the heat of the fire into the shelter. There is some type of sanitary facility nearby and drinkable water.

Designed for through hikers, shelters are occupied on a first-come, first-served basis. Latecomers rig up a shelter outside.

Many hikers carry a tubular plastic material, similar to the gauge and size of a plastic dropcloth used to cover the floor when doing interior home decorating. Use your imagination and materials at hand to form this into a shelter. A piece about four yards long will accommodate two.

There are lightweight tents designed for backpacking that have the advantage of more protection. With a floor and a netting over the entrance they are insect proof, animal proof, and waterproof. Stakes slightly larger than a nail and lightweight telescopic aluminum poles rolled in the tent make a compact package.

Tent material presents a problem. Breath condenses in the watertight nylon tent causing real dampness. Waterproofed cotton, on the other hand, isn't completely watertight. Many backpackers get around this by using a cloth tent and stretching a nylon or plastic fly over it.

The shelter need not be a tent. A nylon ground cloth or a large piece of plastic at least 9x12 feet, preferably with grommets along the sides, can be tied up to trees to give shelter. Some people use their ponchos for this purpose.

There are numerous ways to fix such shelters. String a rope from one tree to another, head high or less. Throw the plastic over the rope and attach corners to other trees, one end lower than the other. Under this shelter meals can be prepared in case of rain and three or four people can sleep. For small shelter, omit the ridge rope and attach the tarp to trees so that it slants.

For a one-man shelter, put part of the ground cloth on the ground as a protection for the air mattress. Then run the ground cloth on a slant over the air mattress and hitch to overhanging branches, thus forming a "V" in which to sleep. If the open end of the "V" is up against a big log, the backpacker has a snug little nest in which to crawl for the night.

See also: CAMPING; CRAFTSMANSHIP; HIKING.

Make Yourself Drown-proof

Even a non-swimmer can learn this technique, and the confidence gained may help you learn to swim

THE QUESTION OF WHETHER we descended from apes would seem to be readily answered if you were to watch a non-swimmer in deep water. Some form of kinship with tree-climbing ancestors is revealed. The non-swimmer tries to climb upward out of the water, which of course, can't be done. If help is not swiftly provided, this instinctive reaction of the non-swimmer can lead only to tragedy.

Four-legged animals, by and large, have no real difficulty when unceremoniously dumped by circumstances into deep water. Their instinct is not to climb, but to work all four legs in a natural, horizontal, walking motion. It comes out as the familiar dog-paddle. They swim by instinct. Humans drown, also by instinct.

There is no need for non-swimmers to drown. Obviously, everyone should know how to swim. Obviously, also, it isn't always possible. It comes hard for some people. There will always be non-swimmers among us, in camp, in canoes and small boats, around ponds, lakes and seashore.

But they need not drown. All it takes is an understanding of instinct, an easily acquired mastery of it, and knowledge of the drown-proofing technique—a widely adopted system originally developed by a swimming coach.

Let's look into the question of instinct first, and devise a way in which you can conquer it so your thinking brain takes command if you unexpectedly find yourself in deep water.

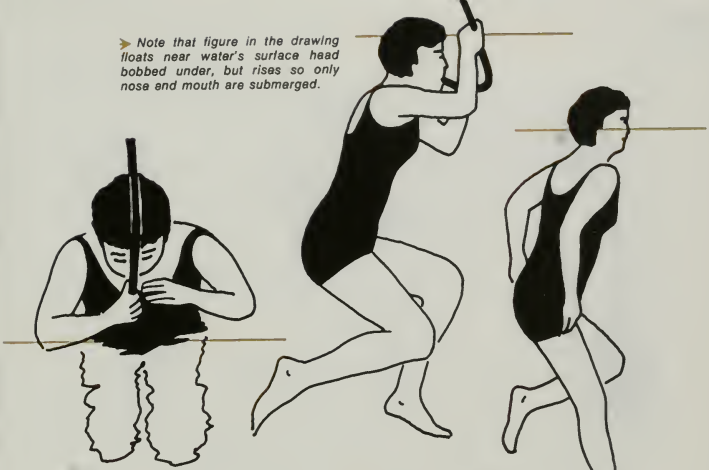
First of all, the normal human body, with air in the lungs, simply cannot sink. Skin-divers and expert swimmers, who often find they must actually struggle to dive downward, know the body possesses buoyancy. The body is a boat. And an unsinkable boat at that. Prove this to yourself and you decrease your chances of drowning, for you will refuse to allow tree-climbing instinct to take command.

Your body will float—somewhat higher in salt water, a bit lower in fresh water. Perhaps the best analogy is to compare it to an iceberg, which also cannot sink. Most of your body will be beneath the surface. Your nose and mouth will even be submerged, which is what frightens non-swimmers who accidentally tumble overboard, and produces pure panic.

This is the key to drown-proofing, which is nothing but a simple technique for breathing while remaining afloat. You can learn it easily from the drawings. But acquired memory can fail you if you suddenly face a water emergency. To retain the knowledge, you need actual training—solid proof that you do, indeed, float and need not drown.

You can prove to yourself that you cannot sink, and do so safely, thereby taking the first step toward mastery of instinct. All you need is access to a swimming pool, and an inexpensive device known as a "snorkel"—a breathing tube used by skin-divers. They're sold by the hundreds of thousands to youngsters and the better quality ones to divers. The cheapest is adequate for your purpose, which is to prove to yourself first of all that you cannot sink. Once you have acquired this confidence, then you are in a far better position in an emergency to recall and apply the academic lessons of drown-proofing.

With the snorkel in hand, get into the



▲ *Use snorkel in very shallow water of pool to demonstrate that you cannot really sink. Sit down, pulling your feet up slowly.*

▶ *Note that figure in the drawing floats near water's surface head bobbed under, but rises so only nose and mouth are submerged.*

▶ *This is drown-proofing. Here the figure floats quietly, as you will note, nose and mouth beneath surface and starts to kick.*

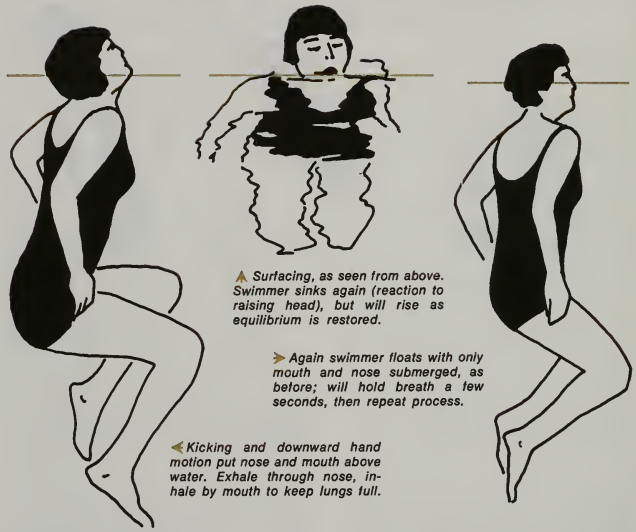
shallow water end of the pool—a bit over waist deep. Be certain you use a pool. Stay out of the ocean, lakes and rivers—any water where there could be current or drop-off. And bear in mind that expert swimmers follow a buddy system and don't go in the water alone. So have someone else around. Never go in the water by yourself.

Put the mouthpiece of the snorkel wholly in your mouth, clamping your teeth lightly down upon the channel grooved into the mouthpiece to assure watertightness. Support the base of the tube with one hand so it protrudes above your head.

Now take a deep breath, hold it, and s-l-o-w-l-y sit down in the water. Pull your feet up off the bottom. It's important to submerge slowly. Squatting rapidly in the water would bob your head well beneath the surface before equilibrium and buoyancy combined to bring it near the top of the water. Keep the hand and arm supporting the snorkel totally underwater. Any weight you raise above the surface only forces you lower down—which is why that tree-climbing instinct proves fatal.

You will find, probably much to your surprise, that you float near the surface. You do not sink, even though your mouth —possibly, in fresh water, even your nose —may be underwater. (You can hold your nose with the other hand, if it'll make you feel better. Non-swimmers don't like the feeling of water entering the nose, which swimmers avoid with breathing techniques we needn't go into.)

Hold your breath at least four or five seconds. Once you stop bobbing slightly and settle at rest near the surface, you can exhale quickly and draw in another breath. You may bob downward an inch or two, but by keeping your lungs full of air you remain very close to the surface. And that



▲ *Surfacing, as seen from above. Swimmer sinks again (reaction to raising head), but will rise as equilibrium is restored.*

➤ *Again swimmer floats with only mouth and nose submerged, as before; will hold breath a few seconds, then repeat process.*

◀ *Kicking and downward hand motion put nose and mouth above water. Exhale through nose, inhale by mouth to keep lungs full.*

is the secret of drown-proofing: to maintain lungs full of air, holding it four or five seconds, exhaling and inhaling swiftly.

Continue once or twice, then stand up for a rest. Repeat it a few times, until you gain absolute assurance and a feeling of faith. Learning the drown-proofing technique without this kind of practice beforehand is almost worthless. You must first arm yourself against panicky reactions in which the instincts rule your brain. These practice sessions with a snorkel do it for you.

Don't tire yourself out. You only want to find assurance that you cannot sink. And you have practiced, in the water, the breathing technique that is the essence of drown-proofing.

Non-swimmers cannot—and should not—venture into deep water just to practice the drown-proofing system. You may find a local swimming group that teaches it under safe, expert supervision. If none is available, you can learn the system from study of the drawings—and armed with your basic instruction gained in shallow water with the snorkel, you can put it to use if you ever face an emergency in the water.

You can practice it in the swimming pool's shallow end, of course, remembering that not even experts go in the water alone. It's a good idea to have a house rule that no one goes in the pool without another member of the family present.

With proper safeguards, you can practice the drown-proofing technique so you can protect yourself with a new set of acquired instincts should you fall into deep water.

Remain in shallow water, waist—or perhaps chest deep—no deeper. Discard that snorkel.

What do you substitute for it? A few kicks of the feet and downward, pushing motions of the hands.

Take a deep breath, and slowly sit down in the water. As before, you'll bob beneath the surface, then find you are settling down with your head at the top and only your nose and mouth submerged—for some people, depending on their build, perhaps even the eyes go under.

Hang limply in the water. Hold your breath four or five seconds. Now to swiftly exhale, you need only push yourself up a few inches to get your mouth above the surface. Raise your arms, palms out and down flat, spread your feet.

Now push downward with the hands and at the same time swing your feet in a good, energetic, scissors kick motion. Your face will break water and come above the surface. Exhale swiftly through your nose, to clear it of water so it cannot trickle back into your throat, making you cough and interfering with the system's success. Inhale through your mouth. It takes but a second.

Your body will once again bob downward. Let it go. You know it won't go but a few inches. Don't fight to keep your face above the surface. Float gently, holding your breath four or five seconds, and then repeat.

This is drown-proofing, and it is this simple. It is nothing more than a technique by which a non-swimmer, who has learned self-control, can continue to breathe. Sum it up in short steps, and it goes like this:

1. Float gently and quietly, without struggling. Hold your breath, lungs full of air.

2. Push downward with your hands, at the same time kicking, to bring your face out of the water long enough to exhale sharply—through your nose—and re-fill your lungs with fresh air.

3. Repeat every four, five or six seconds —depending upon your ability to hold your breath a comfortable length of time.

4. Avoid all unnecessary motion that would tire you out. Do not kick, thrash, climb or struggle. Do not move at all, except when you push yourself upward to breath.

The entire purpose in drown-proofing is to conserve your energy and continue breathing until help comes. If you master the technique you can safely stay afloat until rescued.

Mastery, it must be pointed out again, cannot come from a simple reading of instructions no matter how detailed. Your first problem is to acquire an ability to resist that tree-climbing instinct. This comes only from shallow practice. The snorkel trick helps prove to anyore they simply cannot sink; and it can be practiced in water less than waist deep.

Should you confine yourself to simply reading about the technique, the chances are very good you would completely forget every bit of it if you accidentlly went overboard or strayed beyord your depth. You can build up confidence in the shallow end of a pool where you need only put your feet down to stand up any time you wish. But by all means, seek professional instruction if it is available near your home. And in any event, never go in the water alone.

Meanwhile, there's an enormous psychological benefit in really proving to yourself you cannot sink. It may solve those underlying problems—such as lack of self-confidence—that prevented you from learning to swim.

If this turns out to be true, put yourself in competent professional hands and go all the way. Learn to swim! That's the best way to drown-proof yourself. For drown-proofing is just one step short of swimming. J.M.

See also: SAFETY, BOAT; SAFETY, WATER; SCUBA DIVING.

Basic Swimming Strokes

With these four basic strokes in your aquatic repertoire, you will be a safer, more confident swimmer

KNOWING MORE THAN ONE swimming stroke will give you ease and confidence while you are in the water. In addition, this knowledge could save your life. If you tire while using one stroke, you can partially relieve your fatigue by switching to another. If you suffer a muscle cramp, you can switch to a stroke that uses the muscles in a different way and stretches the cramped muscle.

The sidestroke. This is relatively simple and easy to learn, and the head is carried so that free breathing is possible. It is better to time your breathing to the stroke, but if it is easier for you, you are not forced to do so.

Lie in the water on your side with your legs straight and your toes trailing. Your bottom arm is extended fully forward and your upper arm is at your side with the hand at the thigh. Cradle your head in the water so your mouth and nose just clear the surface.

The lower, extended arm does the work while the upper arm and the legs are moved into position for action. Bend the elbow of the upper arm so the palm and inside of the arm start pressing backward almost directly toward the feet.

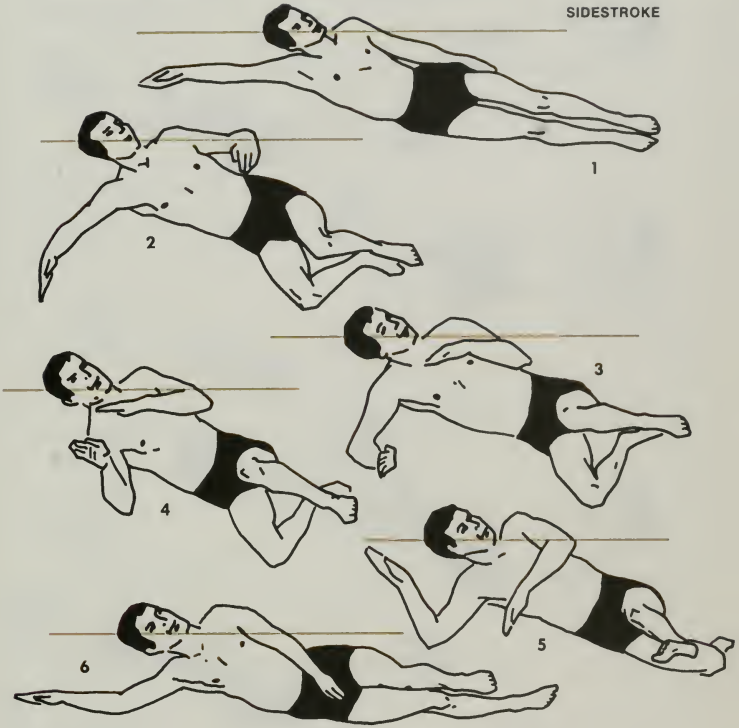
As the arm and hand just pass the shoulder, keep the palm pressing back with the elbow close to the body. Then, in a smooth, easy motion with the palm down and the arm close to the body, return the bottom arm to the extended position.

Meanwhile, as the upper arm makes its propulsive stroke, the bottom arm and legs are moved into position to thrust. To do this, bring the hand of the upper arm to a point about in front of the shoulders. Let the wrist flex and keep the hand close to your body while you do this. Stroke by pressing the hand just about directly backward and downward as the elbow extends, bringing the hand back to its position at the thigh.

The leg action is called the scissors kick. The first part is getting the legs into position—this is done while the lower arm is making its stroke—and the second part is the kick that generates forward thrust.

To get the legs in position, bend the hips, knees and ankles, keeping the heels in line with the back. Draw your legs up toward you in this way, then separate them and extend them at the same time with the upper leg going laterally forward and the bottom leg extending about three quarters to the rear. In a continuous motion, both legs start thrusting by pressing backward, then inward to the center line and close together in the extended position.

Coordination of this stroke is easy. While the bottom arm is thrusting, the upper arm and legs are moving into position. When

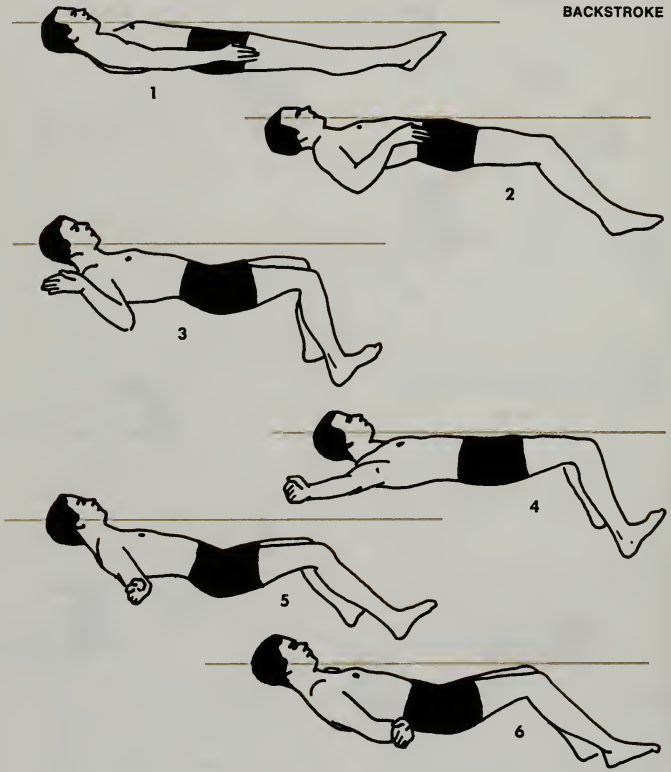


the upper arm and legs are thrusting, the bottom arm is extending forward into position. The recommended timing for breathing is for the swimmer to exhale as the top arm and legs are thrusting, but if the stroke is done properly, the nose and mouth are always out of the water and breathing can be done at any time.

Backstroke. The backstroke is a resting stroke. It requires little effort and a swimmer can breathe without regard to timing, just as in the sidestroke. If you are really puffing, you can do an easy backstroke while you regain your strength.

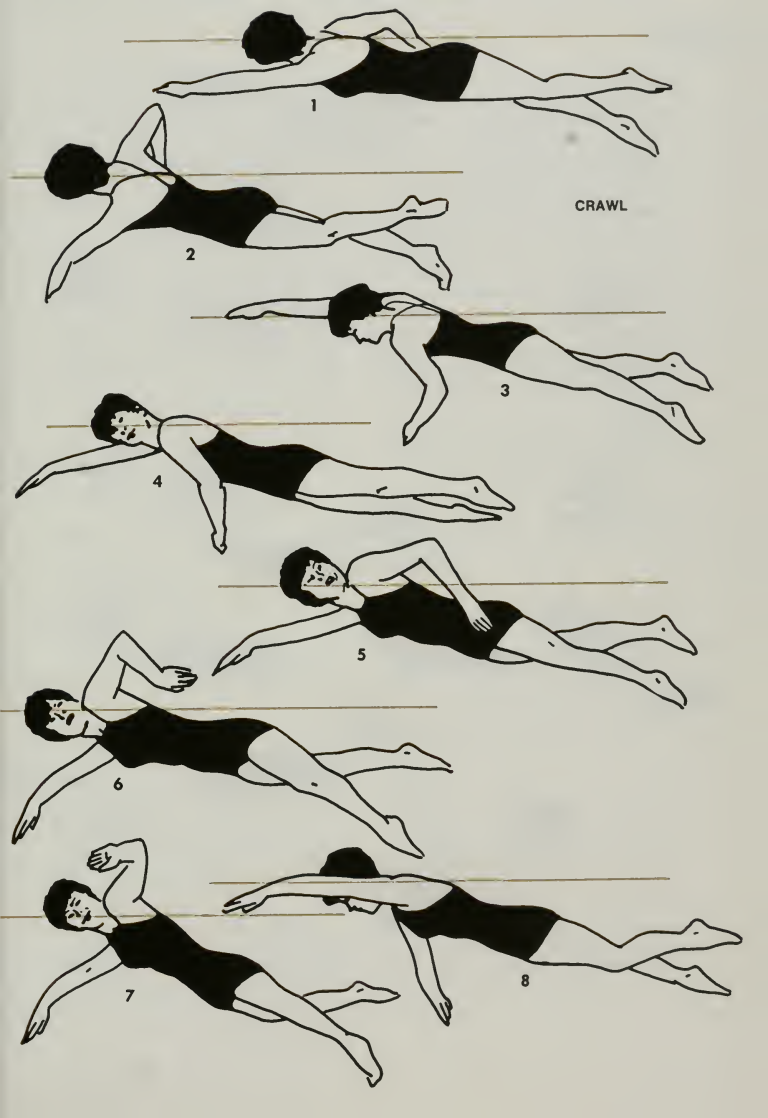
Let your body rest on its back in the water with the head submerged to about

BACKSTROKE



the level of the ears to leave the face out of the water. Keep your back flat, with the legs and hips slanting slightly downward. All arm and leg action is performed underwater.

Draw your hands slowly along your sides, bending the elbows. When your hands reach a point just below your shoulders, extend them outward to a point just beyond your shoulders. The fingers are pointed outward and the palms face your feet. Your arms are ready to stroke.


CRAWL
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To stroke, press your palms toward your feet in a sweeping arm motion until your hands return to your thighs.

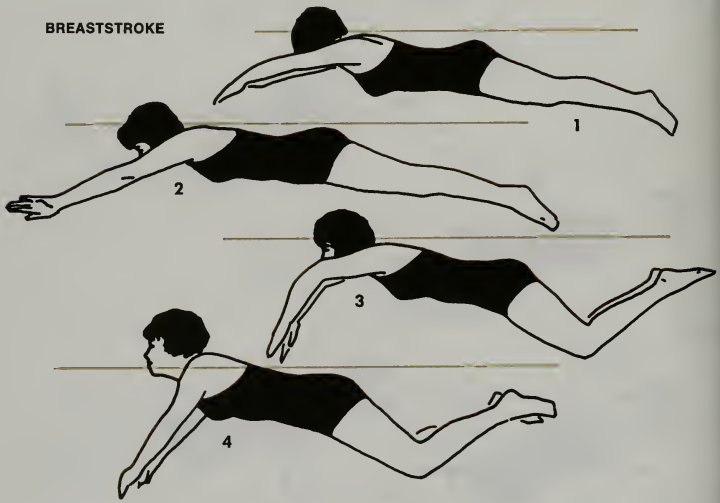
Leg action begins with the legs together, fully extended. Bend the knees and ankles so the heels drop down and move back toward the hips. When the heels are directly below the knees, rotate your feet so the toes point outward. Your knees will spread slightly. Rotate the feet to a position outside the knees. Then, thrust the legs backward and upward, so they close in the same position as they were in at the start. Thrust is achieved by the pressure of the lower leg and foot against the water. The whole procedure is done as one continuous motion.

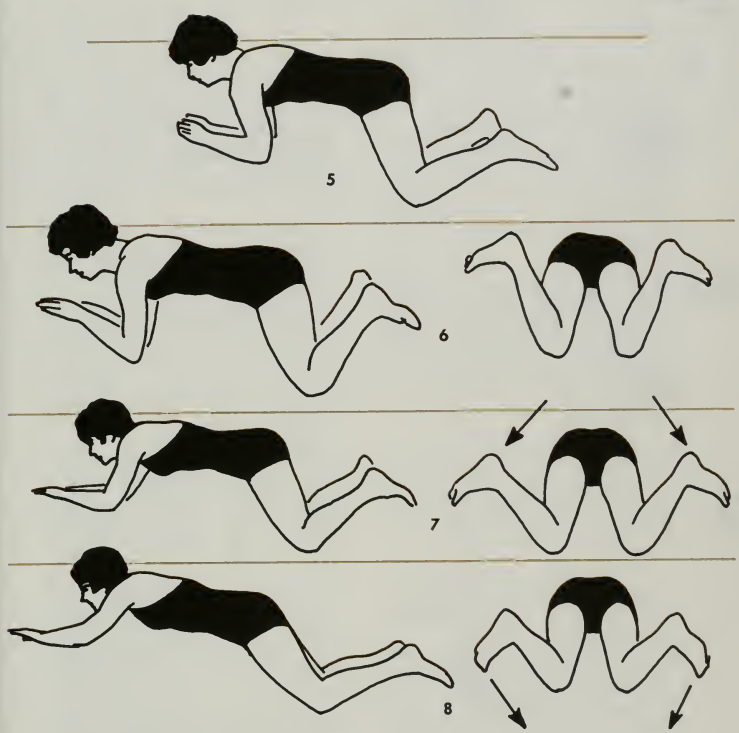
Coordinate the arm and leg actions of the backstroke by starting to bring the arms into position first. When the hands have been pulled to about the waist, start bringing the legs into position. This way, both arms and legs will be in a position to thrust simultaneously. Breathing is free because the nose and mouth are out of the water at all times, but the most efficiency is achieved by breathing once per stroke.

Breaststroke. The breaststroke is a good alternative stroke and is widely used in life saving because it is fairly fast and it allows the swimmer, by raising his head, to have optimum forward vision.

Maintain your body in a streamlined horizontal position face down in the water with the head held so the water is at about the level of your eyebrows.

The arms and hands are extended forward in the water. Begin the arm stroke by pressing the palms diagonally downward to just outside the shoulder line. Keep





the elbows high and press the arms almost diagonally backward in a continuous movement. Don't bring the palms past the elbows. During the thrusting action, the palms and the insides of the arms press back toward the feet.

At the end of the thrust, bring the hands fairly close together in a rounded motion. Then extend the hands and arms to the starting position forward of the body.

Start leg action with your legs extended in line with your trunk just below the surface. Keep your heels slightly apart and draw them toward the trunk, keeping them slightly below the surface. When the heels are almost over the knees, your feet are tilted so your ankles are bent and the toes are pointing to the side. Your knees will spread slightly and your feet will rotate to a position outside your knees.

Thrust in a continuous motion, extending the hips, knees and ankles, bringing the feet a little out and back through an arc to the extended position.

Your sole, instep and the inside portion of your calf will thrust almost directly back against the water. Remember, it is the backward thrust of the legs rather than the closing action that provides propulsion, so don't waste energy trying to make too wide a kick.

To breathe, raise the head just enough to inhale while the arms are thrusting backward. Exhale while the face is immersed.

To coordinate the action of your arms and legs, start drawing your heels forward for the thrust of the legs while the arms are ending their thrusting stroke. The legs kick while the arms are returning to the starting position.

Crawl. The fastest stroke is the crawl. It is almost one of the most efficient because the forward motion of the arms to get them into thrusting position takes place out of the water rather than in it and the kick is performed in the long axis of the body and arms.

Start in a horizontal, face-down position. The head is aligned with the body. The waterline is at the middle of the forehead. The arms and legs are extended.

Raise one arm and dig your hand into the water about in front of the head, leading with the finger tips. Angle the arm forward and downward and flex the wrist slightly so the palm faces almost directly backward. Press the hand backward near the centerline of your body as the elbow bends.

At the midpoint beneath the body, the palm continues pushing backward and the elbow gets nearer the trunk. As your hand pushes away from your trunk, swing it upward out of the water as it continues its motion, but do it in such a way that neither the palm nor the back of the hand are pressing the water. Just withdraw it.

Bringing the arm out of the water and back to dig in again should be an easy relaxed motion from the shoulder. An easy roll of the trunk will help. Roll away from the arm you are withdrawing and toward the propelling arm. Just roll easily. Do not bend from side to side or you will increase your resistance to passage through the water.

Actually, you can swim fairly well with the arm motion of the crawl, but a kick will add some momentum and it will improve your stability.

This kick is called the flutter kick. It is an up and down motion of the legs originating from the hip with an undulating action of the lower leg and foot. You achieve this by just using your upper leg to kick with. The knees, ankles and feet should be relaxed and swing freely.

Since kicking adds relatively little momentum, do not overkick. You will just waste energy. Generally, there are three downward beats to each arm stroke, with the leg on one side making a down stroke as the arm on the opposite side enters the water.

Coordinate your breathing with your arm stroke. Do not raise your head to take a breath, rotate it just enough to lift the mouth and nose above water level. Rotate it toward the arm that is just finishing a propulsive stroke. As you roll slightly away from that arm and lift it from the water, your mouth will be above the waterline. Take a quick breath. Exhale slowly underwater. You should just finish exhaling as the head rotates to take the next breath.

If your head is properly cradled in the water and you have sufficient speed, your face will make a slight trough in the water. Then, you have only to rotate your head enough to get your mouth above the bottom of the trough to take a breath rather than all the way above the waterline.

See also: SAFETY, WATER; SCUBA DIVING; WATER SKIING.

Swimming Underwater

These intermediate aquatic skills can increase your pleasure at beach, lake and pool, and can occasionally be useful

UNDERWATER SWIMMING is fun and it can be useful—if, for example, you drop your keys to the bottom of the pool.

It can also be dangerous, if you don't know the nature of the hazards. All the ordinary rules for safe swimming apply, particularly the one that warns against swimming alone. Another is to be especially cautious in water that is unfamiliar to you.

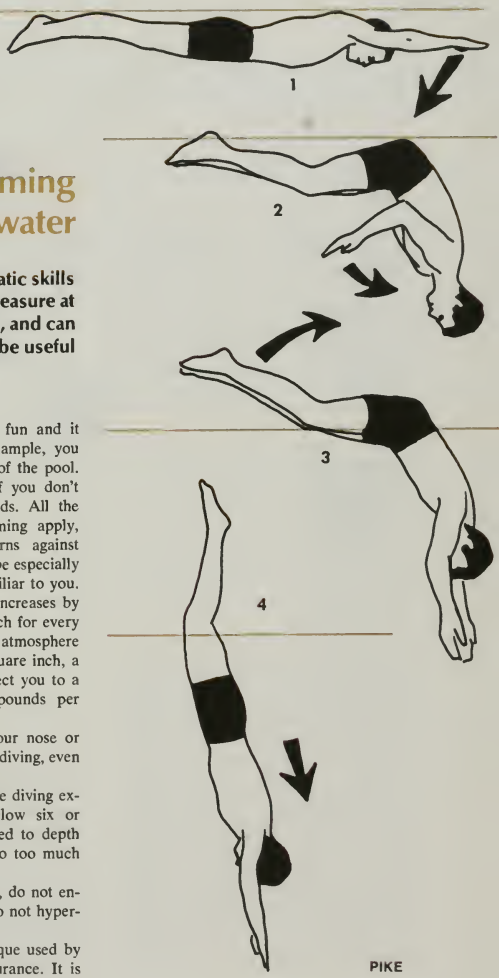
In addition, water pressure increases by about one pound per square inch for every two feet of depth. Since average atmosphere pressure is 14.7 pounds per square inch, a dive of 15 or 16 feet will subject you to a total pressure of about 22 pounds per square inch.

If you have trouble with your nose or ears, consult a physician before diving, even to shallow depths.

Generally, a person with little diving experience should not swim below six or eight feet until he is accustomed to depth and even then he should not go too much deeper.

When swimming underwater, do not engage in distance contests and do not hyperventilate before diving.

Hyperventilation is a technique used by some athletes to increase endurance. It is



PIKE

done by deep breathing before exertion. The deep breathing reduces the amount of carbon dioxide in the blood.

This sounds like a great idea, and it is under proper supervision and with lots of emergency help available, but it also can be fatal.

The human respiratory system feeds the bloodstream oxygen and removes carbon dioxide. If you attempt to hold your breath as long as you can, it is the accumulation of carbon dioxide that gives you the compelling urge to take breath.

However, if you have reduced the carbon dioxide level in your blood by hyperventilation, you may black out from lack of oxygen before the carbon dioxide level in your blood gets high enough to signal you that you must breathe.

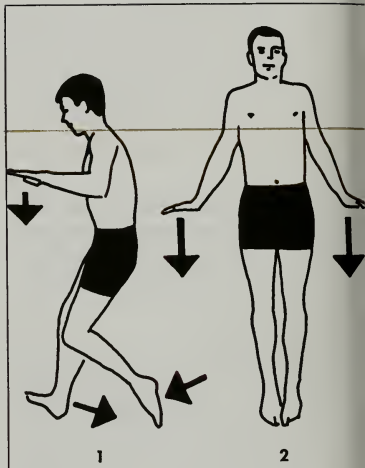
If you did this out of the water, your autonomous nervous system would take over when you passed out and you would start breathing again. If it happens to you in the water, you will drown.

There are four kinds of dive that will get a swimmer from the surface to the underwater level that he wishes to reach. These are the pike, the tuck, the quick dive and the feet-first dive.

The pike. Start the pike from a face-down prone swimming position while you still have momentum. The arms should be extended forward. Press the arms backward in a broad sweep to your sides. At the same time bend at the hips so your body is vertical in the water, but your legs are horizontal.

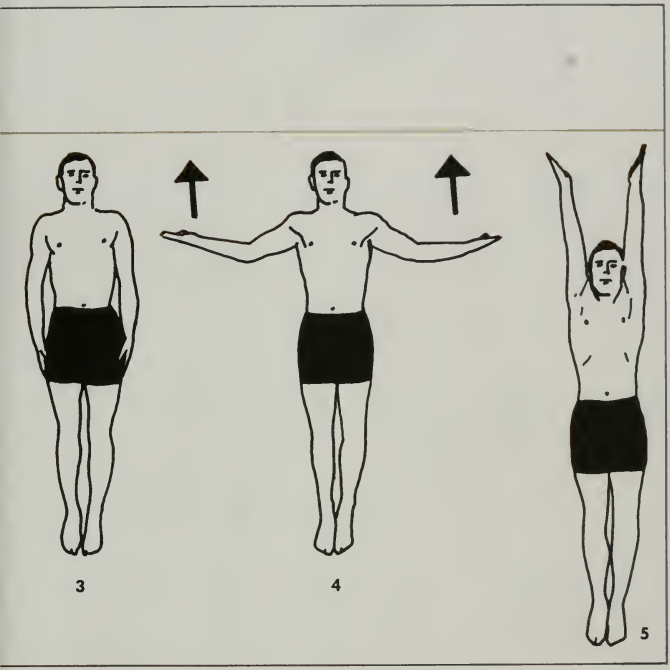
Without pausing, circle the arms forward vigorously and bring your hands together in a streamlined driving position. At the same time raise your legs to a vertical position. Your body is now in a vertical position heading downward and slightly forward in the water. It should get you to a depth of about 8 feet, with no additional stroking of the arms.

The tuck surface dive. This is like the pike with the exception of leg action. As you sweep your arms back and bend at the hips, draw your legs toward you and tuck them underneath. This will speed the rotation of your body downward. Then, in a continuous motion, thrust your legs upward toward the sky after you have moved your arms and hands to the streamlined diving position. You will find yourself heading downward just as in the pike.



FEET-FIRST DIVE

The quick surface dive. This dive is used



by life savers to reach drowning victims rapidly. However, you may want to get to the bottom quickly for other reasons, or just for the fun of it. Don't attempt to swim or dive to a drowning swimmer unless you know exactly what you are doing.

The quick surface dive is actually a pike executed while you are swimming. You need momentum to do it effectively. If you are doing the crawl, leave the forward arm where it is, complete the stroke of the other arm and bring it forward to join the extended arm. Without pausing, bend downward from the hips, sweep the arms backward, then forward into diving position and raise the legs to the vertical position of the pike. You are on your way down.

The key to successful execution of this dive is to keep momentum, which allows you to rotate your body into vertical position very quickly.

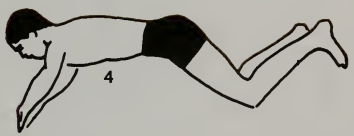
Feet-first dive. Diving feet-first is the

safest way to enter murky water, especially when you do not know how deep it is or what the bottom is like.

Start in a vertical position, as if treading water. The important thing is to get the body upward so it will drop down vertically. To do this, extend the arms outward. Simultaneously sweep the arms downward and execute a scissors kick or a breaststroke kick. This action will lift your body upward in the water. At the highest point, your hands should be at your sides and your legs should be extended with the toes pointing downward.

As you sink, rotate the wrists so the palms face out, and when your head goes below the surface, sweep the arms upward, pressing them against the water to drive your body downward. This action will bring you to a depth of as much as ten feet. There, you can elect to level off and swim underwater or, if you wish, go deeper. Just do a tuck as you would on the surface and continue toward the bottom.

The most common method of swimming underwater is a modified version of the breaststroke. Change the arm action by sweeping the arms all the way back, so the motion is completed with the hands at the thighs, palms upward. At the end of the stroke, extend the arms forward for another stroke by drawing the hands forward along and under the body. Time the kick so the legs are fully extended when the thrust of the arms is completed.



You can also use a scissors kick or a crawl if you wish, and you can do a version of the sidestroke. If you are in dark or murky water, stick to the modified breaststroke because it will keep your hands in front of you more of the time than the other strokes will.

See also: SAFETY, WATER; SCUBA DIVING.